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FEASIBILITY STUDY REPORT SITE 38 NAS PENSACOLA FL
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ENSAFE/ALLEN AND HOSHALL

**FEASIBILITY STUDY REPORT
SITE 38
NAS PENSACOLA
PENSACOLA, FLORIDA**



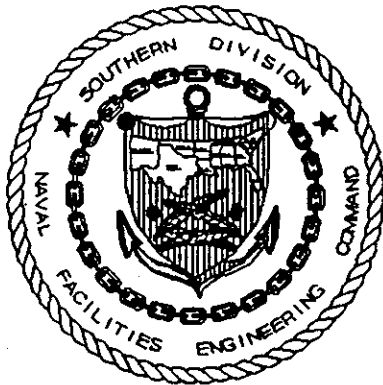
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Naval Air Station
Pensacola, Florida**

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**Release of this document requires prior notification of the
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Pensacola, Florida.**

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ACRONYMS

$\mu\text{g/L}$	micrograms per liter
ARAR	Applicable or relevant and appropriate requirements
BEHP	bis(2-ethylhexyl)phthalate
BEQ	benzo(a)pyrene equivalent
bgs	below ground surface
BRA	Baseline Risk Assessment
BRAC	Base Realignment and Closure
CEC	cation exchange capacity
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CG	Cleanup Goal
CHIL	Consolidated Hazardous Item List
COC	contaminant of concern
COD	chemical oxygen demand
CTL	Cleanup Target Level
CY	cubic yard
DCA	dichloroet
DCE	dichloroethene
DNAPL	dense non-aqueous phase liquid
DO	dissolved oxygen
FAC	Florida Administrative Code
FDEP	Florida Department of Environmental Protection
FGGC	Florida Groundwater Guidance Concentration
FOTW	Federally Owned Treatment Works
FPDWS	Florida Primary Drinking Water Standards
FS	feasibility study
FSDWS	Florida Secondary Drinking Water Standards
G&M	Geraghty and Miller
GC	General Criteria
gpd	gallons per day
gpm	gallons per minute
HDPE	high density polyethylene
HI	hazard index
ISCTLs	Industrial Soil Cleanup Target Levels
IWTP	Industrial Wastewater Treatment Plant

LUCAP	Land Use Control Assurance Plan
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MNA	Monitored Natural Attenuation
msl	mean sea level
MSWQ	Marine Surface Water Quality
mV	millivolts
MWR	Morale, Welfare, and Recreation
NADEP	Naval Aviation Depot
NAS	Naval Air Station
NCP	National Contingency Plan
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
OSWER	Office of Solid Waste and Emergency Response
OU	Operable Unit
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCE	tetrachloroethene
PPE	personal protective equipment
PRB	passive reactive barrier or permeable reactive barrier
PRG	Preliminary Remediation Goal
PVC	polyvinyl chloride
RBC	risk-based concentration
RC	reference concentration
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RG	remedial goal
RI	remedial investigation
RO	reverse osmosis
ROD	Record of Decision
RSCTLs	Residential Soil Cleanup Target Levels
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SEGS	Southeastern Geological Society

SL-GW	Soil Leach – Groundwater
SL-SW	Soil Leach – Surface Water
SMCL	Secondary MCL
SQAG	Sediment Quality Assessment Guidelines
SSL	Soil Screening Level
SSV	Sediment Screening Value
SVE	soil vapor extraction
SVOC	semivolatile organic compound

TBC	To Be Considered
TCE	trichloroethene
TEL	Threshold Effects Level
TKN	total kjeldahl nitrogen
TOC	total organic carbon
TSS	total suspended solids
TVOC	total VOCs

USEPA	U.S. Environmental Protection Agency
USGS	U.S. Geological Survey
UST	underground storage tank

VC	vinyl chloride
VOC	volatile organic compound

EXECUTIVE SUMMARY

SITE 38 – BUILDINGS 71 AND 604

A feasibility study (FS) was conducted for Site 38 at Naval Air Station (NAS) Pensacola. Site 38 addresses contamination associated with former operations at Buildings 71 and 604. The FS reviewed site contamination summaries presented in the remedial investigation (RI) and applicable or relevant and appropriate requirements (ARARs). These data were used to establish remediation goals (RGs) for Site 38 and to develop remedial alternatives appropriate to the contamination present at each site.

State of Florida Soil Cleanup Target Levels (SCTLs) presented in Florida Administrative Code (FAC) 62-777 were identified as To Be Considered criteria for remedial actions onsite. A review of site contamination, as well as land use considerations, resulted in the selection of industrial standards as RGs. All soil alternatives (except the no-action alternative) include provisions for institutional controls, which will ensure long-term site use remains industrial. Subsurface soil was reviewed and compared against leaching criteria presented in FAC 62-777, but no continuous subsurface source mass was identified; no remediation goals were developed for subsurface soil. Per FAC 62-550, drinking water standards are appropriate remedial goals for groundwater.

Soil Evaluation

Soil contamination at Site 38 exceeds industrial RGs and poses a threat under a future industrial worker scenario: 21 out of 99 locations exceed one or more RG (six locations at Building 71 and 15 locations at Building 604). Of these locations, only six are exposed surface soil: all exposed surface soil points are in the Building 604 complex. No RG exceedances are exposed in the Building 71 area.

The total volume of exposed surface soil impacted at Site 38 is relatively small, approximately 400 CY, and includes a parking lot median as well as five small, discontinuous areas at the edges of the Building 604 complex parking lots. Arsenic is the sole constituent of concern in exposed

surface soils at Site 38. Exceedances range from a approximately 4.0 mg/kg to a maximum of 7.2 mg/kg, less than two times the RG, representing an overall risk of approximately 2E-06.

Because current and projected land use is expected to remain industrial, and the impacted locations comprise roughly 5,500 square feet, or 3% of the total surface area at Site 38, a full remedial technology screening was not performed. A limited number of alternatives, consistent with site use projections, were retained for evaluation:

- No Action, as required by the National Contingency Plan
- Institutional controls, which will be needed to maintain the industrial-use classification
- Capping

The no-action alternative for Site 38 involves no active remedial effort: no actions will be taken to contain, remove, or treat soil contamination above RGs. While current and projected site use is industrial, the FS discusses this alternative as an unrestricted site use scenario, in which residential exposures to contaminated soil are possible.

The FS presents the institutional controls alternative for Site 38, which uses land use restrictions to prevent uncontrolled exposures. No actions will be taken to contain, remove, or treat soil contamination above RGs. Soil would remain in place and institutional controls would be incorporated into the Land Use Control Assurance Plan (LUCAP) to ensure Site 38 remains an industrial use area.

The asphalt cap alternative is discussed in this FS as a physical barrier to cover the exposed locations where contaminants exceed RGs, thus eliminating the exposure pathways. In conjunction with the cover alternative, land use will be restricted to industrial to minimize uncontrolled exposure and prevent cover disturbance.

Groundwater Evaluation

Groundwater at Site 38 exceeded RGs at one or more locations for the following compounds: antimony, arsenic, cadmium, chromium, lead, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, bis-(2-ethylhexyl)phthalate, chrysene, 2,4-dinitrotoluene, naphthalene, 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, benzene, chloroethane, chloroform, ethylbenzene, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethene, 1,2-dichloroethene (total), cis-1,2-dichloroethene, 1,1,2,2-tetrachloroethane, tetrachloroethylene (PCE), 1,1,1-trichloroethane (TCA), trichloroethylene (TCE), and vinyl chloride. However, the majority of exceedances are chlorinated volatile organic compounds (VOCs) (e.g., PCE, TCE, 1,2-dichloroethene, and vinyl chloride) and lead. An estimated 12.2 million gallons of groundwater impacted by RG exceedances is present at Site 38.

Four alternatives were evaluated for groundwater at Site 38:

- **Alternative G1:** No-action
- **Alternative G2:** Monitored natural attenuation
- **Alternative G3:** Enhanced bioremediation
- **Alternative G4:** Groundwater extraction and disposal to the Federally Owned Treatment Works (FOTW)
- **Alternative G4a:** Groundwater extraction followed by coagulation/precipitation for inorganics pretreatment and air stripping for removal of VOCs.

Preliminary sampling performed in 1998 and 1999 are strongly indicative of monitored natural attenuation (MNA) processes (e.g., reductive dechlorination) within the aquifer for organic compounds. Moreover, data also suggest that lead is precipitating out as lead sulfide (PbS) concurrent with reductive dechlorination mechanisms. This FS presents an MNA alternative

which would monitor site groundwater to verify processes will meet RGs within reasonable time frames.

Enhanced bioremediation is used when MNA processes are insufficient to completely degrade site contaminants, or when reaction kinetics are too slow. While many types of enhancement are possible, this FS evaluates the potential for enhancing the reducing environment further.

Groundwater pump-and-discharge was evaluated to determine potential flow rates as well as costs associated with a containment remedy. If direct discharge to the FOTW is not possible, the FS also presents a treatment option to reduce concentrations of VOCs and inorganics in the discharge stream.

1.0 INTRODUCTION

The purpose of this Feasibility Study (FS) is to develop, evaluate, and compare remedial action alternatives that will be used to mitigate hazards and threats to human health and the environment from soil and groundwater contamination at Site 38, at the Naval Air Station (NAS) Pensacola. This FS addresses remedial alternatives for soil and/or groundwater at the two areas addressed under Site 38: Building 71 and Building 604.

This FS is being performed under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) and the Superfund Amendments and Reauthorization Act of 1986, based on the findings reported in the *Final Remedial Investigation Report Site 38, Naval Air Station, Pensacola, Florida* (EnSafe Inc. 1998).

The organization of this FS report has been adopted from the format suggested in Office of Solid Waste and Emergency Response (OSWER) Directive 9355.3-01, *Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA* (Interim Final, October 1988).

This FS is streamlined to provide an effective and efficient evaluation of remedial action alternatives and is organized in the following manner:

- Section 1, Introduction
- Section 2, Feasibility Study Process
- Section 3, Groundwater Feasibility Evaluation
- Section 4, Soil Feasibility Evaluation

Section 1 presents site history and background information for Site 38 and summarizes the results of previous investigations, including the remedial investigation (RI) and baseline risk assessment (BRA).

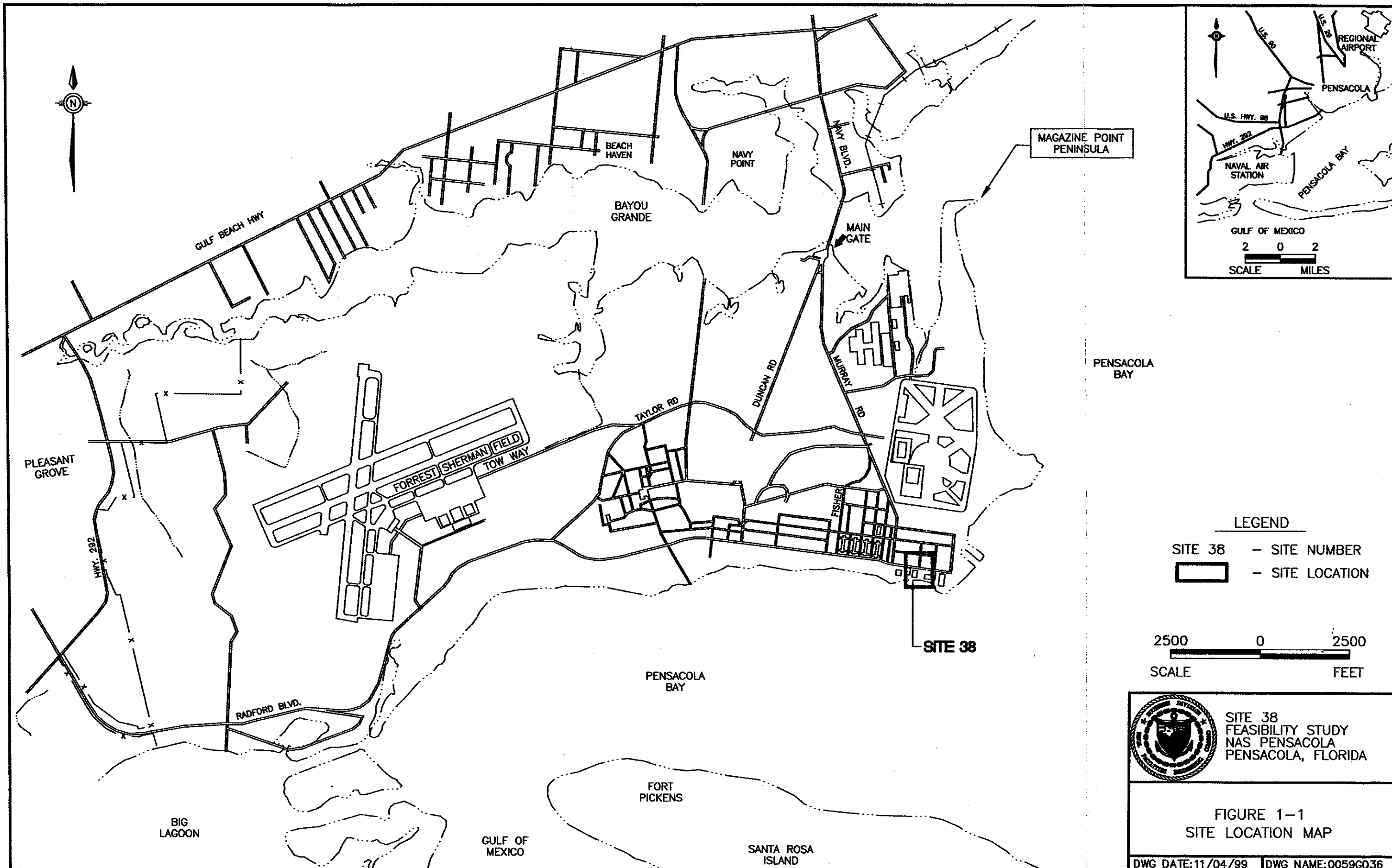
Section 2 summarizes the general FS process, discussing major considerations for each task outlined below.

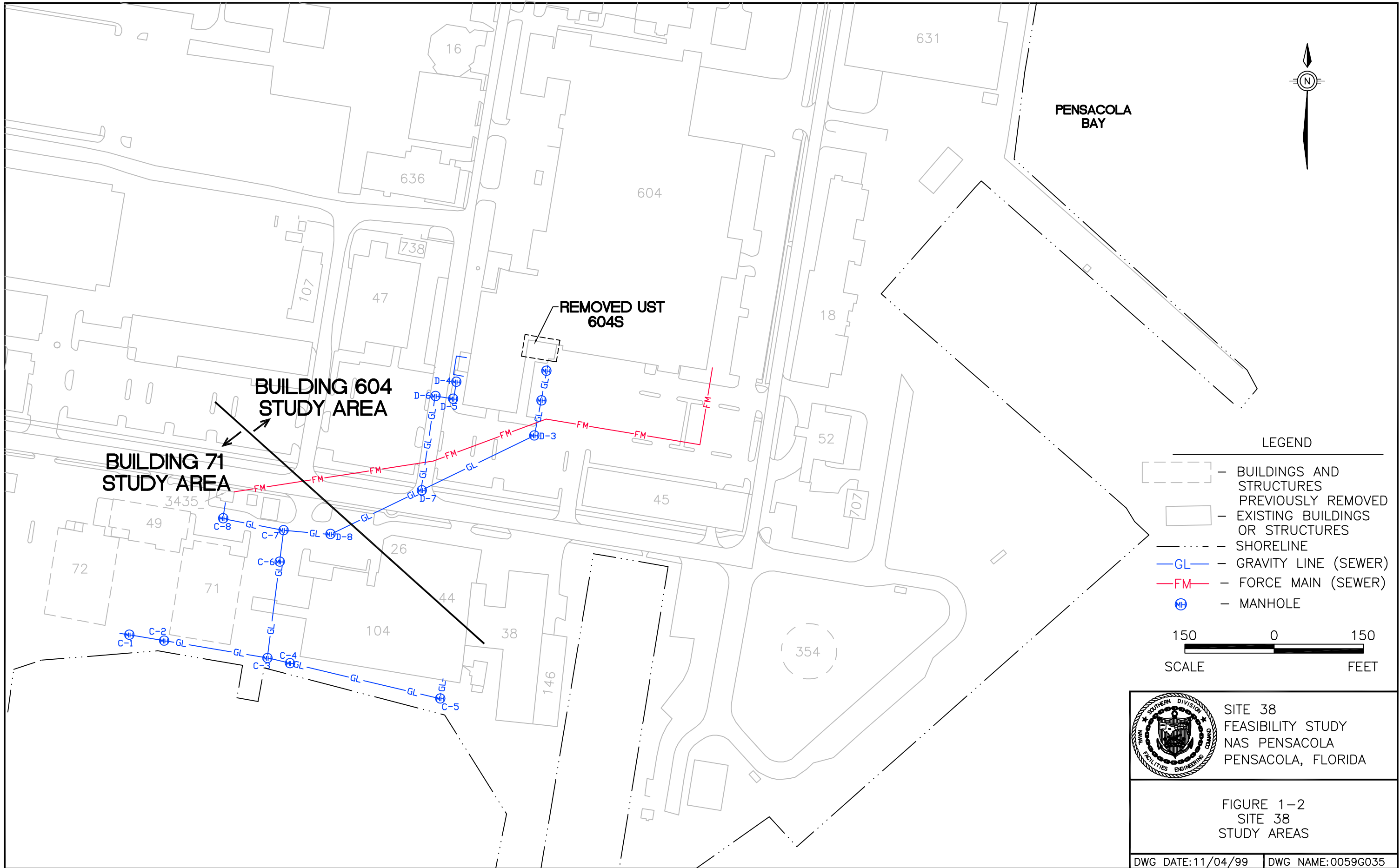
- Steps to define the remedial action objectives and areas requiring remedial analysis.
- Initial screening for remedial technologies.
- Development of remedial alternatives, including an implementability, effectiveness, and cost screening.
- Detailed analysis of alternatives.
- Comparative analysis of alternatives.

Because soil contamination and surface conditions vary across Site 38, soil for each area (i.e., Building 71 and 604) is evaluated separately.

1.1 Site Description and History

Site 38 is in the southeastern portion of NAS Pensacola, as shown on Figure 1-1. This site includes former Building 71 and surrounding areas, Building 604 and surrounding areas, and the associated IWTP sewer line (TL 073/C southwest to the end). The site was divided into two study areas; the Building 71 area and Building 604 area (Figure 1-2). The general area surrounding the site is used for storage, maintenance, and operations support for Morale, Welfare, and Recreation (MWR). Most of the area is paved with asphalt or concrete with exposed soil only along the road or in parking lot medians. The southern part of the site is adjacent to Pensacola Bay. The immediate offshore area was investigated in the Site 2 RI (E/A&H, 1996a). Port operations and the main ship docks are to the east.





SITE 38
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 1-2
SITE 38
STUDY AREAS

1.1.1 Building 71 Area

Building 71 was a steel-framed structure with a metal covering on a 10-inch to 14-inch-thick concrete slab. The structure was approximately 100 feet wide by 160 feet long and approximately 35 feet high. An interior concrete block wall divided the structure into a northern half, curbed with concrete in several places, and a southern half enclosing 10 dip tanks. The building was demolished in September and October 1993. Building 71 was used from 1935 to the late 1970s for aircraft paint stripping and painting operations. Before approximately 1973, wastes from various operations, including paint stripping, were discharged to Pensacola Bay. After the IWTP was built in 1973, wastes entered the associated IWTP sewer line without any pretreatment or segregation. Currently, the vacant lot where Building 71 stood is being used by MWR for parking large trucks.

Structures surrounding Building 71 include Buildings 104, 26, and 44 immediately to the east and the former Buildings 72 and 49 to the west. Building 72, demolished in March and April 1993, was also used for paint stripping and painting operations. Building 49, used for painting operations, was demolished in September and October 1993. A storage yard, approximately 90 feet wide by 145 feet long, was between Buildings 71 and 72; Building 49 was at the north end of the storage yard. Building 104 was a Navy Exchange warehouse operated by the Navy Commissary. The facility was originally used in painting operations and was later converted to a sheet metal shop in the 1960s. Building 26 was constructed in 1882 as a blacksmith shop functioned as a foundry for Naval Aviation Depot (NADEP). No foundry operations are currently being performed at the facility. Notably, this facility is currently undergoing Resource Conservation and Recovery Act (RCRA) closure.

History

Building 71 was originally constructed as a seaplane hangar in the early 1920s. In approximately 1935, operations changed to paint stripping (NEESA, 1983). In addition to Building 71, Buildings 72 and 49 were also used for paint stripping from 1935 to the mid-1970s. The Naval Energy and Environmental Support Activity (NEESA, since renamed) reported that an estimated 400 gallons per day (gpd) of acrylic and epoxy paint stripper and another 400 gpd of ketone were used at these buildings during stripping operations. Other compounds believed to have been used include phenols and trichloroethene (TCE). A system of interconnected, grated drains and trenches in the building floor and storage yard collected waste solvents used in the stripping operations. Small parts were stripped and cleaned in ten 500-gallon dipping tanks in the southern portion of Building 71. The contents of these tanks (reportedly paint strippers, ketones, and TCE) were drained into the floor trenches every six to eight weeks (NEESA, 1983). This floor trench drained directly into Pensacola Bay for several decades until the early 1970s, when it was connected to the IWTP sewer line. When the buildings were demolished, drainage trenches in the west yard and inside Building 71 were filled with concrete. In 1979, paint stripping was moved from Buildings 71 and 72 to Building 3557 (NEESA, 1983).

From 1980 to 1989, hazardous waste was stored on the north side of Building 71, which was permitted for hazardous waste storage in January 1985 by the Florida Department of Environmental Regulation (FDER) which was later renamed Florida Department of Environmental Protection (FDEP) (Kriegel, 1985; NEESA, 1983). Eighty to several hundred 55-gallon drums were reported to have been stored in Building 71; the maximum permitted storage capacity was 15,950 gallons (i.e., 290 55-gallon drums). Waste stored during this period reportedly consisted of solvents, acids, caustics, oxidizers, and liquid and nonliquid toxic materials (E&E, 1992a).

1.1.2 IWTP Sewer Line Area

The associated IWTP sewer line includes gravity lines as well as a force main. Except for the 18-foot section of line between manholes C-2 and C-1 constructed of 8-inch diameter polyvinyl chloride (PVC) pipe, the lines in this area are constructed of 8- to 12-inch diameter vitrified clay with hub and spigot joints.

Building 3435, north of the Building 71 area, housed the lift station for the force main. The interconnected gravity lines, which served operations at Buildings 604 and 104, and previously served operations at Building 71, flowed to the lift station at Building 3435. The force main extended northeast from the lift station between Buildings 604 and 45 and continued north (east of Building 604) beyond the study area, where it eventually discharged to the former IWTP north of Chevalier Field.

Wastes from various types of operations entered the IWTP sewer line without pretreatment or segregation. In this area, the IWTP sewer line serviced former Buildings 49, 71, and 72 and Building 604. Consequently, the waste stream may have consisted of everything generated or used in those buildings including metal waste, paint strippers, ketones, TCE, and cyanide (before 1962).

In 1995, the IWTP was closed; currently the Federally Owned Treatment Plant (FOTW) accepts only domestic and non-industrial (i.e., warehousing) wastewater. Old gravity IWTP lines were grouted as part of this closure, while force mains were cleaned.

1.1.3 Building 604 Area

Building 604 housed the ADEP metal plating operations until the facility was closed in May 1996. Building 604 is a two-story, irregular, brick/masonry structure built in 1937 as a hangar on the west side of East Avenue in the old Navy Yard. The building is not listed in the

National Register of Historic Places; however, it was identified as possibly being eligible for listing. Plating operations were conducted in Buildings 29/604a, the western extent of Building 604, from around 1960 until the shop was demolished around 1970 (NEESA, 1983). The rubber shop, which made plastic items for aircraft, was also housed in Building 29 until 1961. This shop only used small amounts of solvents. Three cadmium plating lines and a magnesium treatment line were in the plating shop. Chromium was used in the magnesium treatment process. NEESA (1983) reports that 50-gallon tanks containing chromium solutions were drained once a month; larger tanks were present but were drained less frequently. These tanks were emptied into sewer lines that discharged into Pensacola Bay (NEESA, 1983). Cyanide solutions were also used in the plating process. Prior to 1962, cyanide waste was disposed in the sanitary sewer. Because plating wastes could upset the operation at the sewage treatment plant, cyanide and chromate wastes that were dumped into the sewer system were routed to bypass the treatment plant and flowed untreated into Pensacola Bay.

Around 1970, a much larger plating shop, the southwest extension of Building 604, was constructed at the site of Building 29/604a. Hazardous materials have been stored in Building 604, on the second floor, since the early 1970s. All chemicals designated for separate storage on the Consolidated Hazardous Item List (CHIL) were consolidated into one segregated storage area. Reportedly, the storage area was reorganized and cleaned up in 1981. Before that time, spills and leaks frequently occurred (NEESA, 1983).

Approximately 30 plating process tanks were present in the Building 604 shop ranging in size from 40 gallons to 2,000 gallons. These tanks were drained about once a month. From 1970 to 1973, discharge was through sewer lines that emptied into Pensacola Bay. After 1973, most drain lines were connected to the IWTP; however, NEESA (1983) reports that some of the lines may not have been connected to the IWTP until 1979, and untreated liquid waste may have been unintentionally discharged to Pensacola Bay. According to an interview with Frank Stewart,

Environmental Engineer for NADEP, work on the storm sewer lines from Building 604 around 1985 found that the line leading to Outfall 1 at Site 2 had not been sufficiently plugged or diverted and that liquid waste from the facility may have been unintentionally discharged up until this time.

1.1.4 Building 38 Description and History

Building 38 houses Port Operations. Large bays in the building are used to maintain small boats. Shop areas and office space are in the facility. Before Port Operations moved there, the building was a machine shop for NADEP, housing sheet metal, carpentry, and welding shops. Building 38a was used to maintain industrial instruments. According to engineering drawings in Building 44, Building 38 was built in 1882. The area surrounding the facility is paved with concrete and asphalt. No previous investigations have occurred at Building 38.

1.1.5 Building 636 Description and History

Building 636 was constructed in approximately 1940 to serve as a laundry and dry cleaning facility. The dry cleaning unit was in the southeast part of the building. The facility served as a laundry until approximately 1970, when it was converted to office space. At the time of the USEPA investigation in 1995, the building was closed. No previous investigations have occurred at Building 636.

1.1.6 Sanitary and Storm Sewer Drainage Systems

Historically, industrial waste from Buildings 71, 72, 49, and 604 were discharged via the storm drainage system to Pensacola Bay prior to completion of the IWTP line in 1973. No previous investigations of the storm drainage system have occurred. Sanitary waste from these facilities was discharged to the bay prior to the 1940s when it was routed to the sanitary sewer treatment plant. As stated previously, the industrial portion of the wastewater treatment plant was shut down in 1995. The FOTW now only accepts domestic and non-industrial wastewater.

1.2 Environmental Setting

1.2.1 Physiography

NAS Pensacola is in the Gulf Coast lowlands on a peninsula bounded by Pensacola Bay to the south and east and Bayou Grande to the north. The main topographic feature is a bluff paralleling the southern and eastern shorelines of the peninsula. Landward of the bluff is a gently rolling upland with elevations up to 40 feet above mean sea level (msl) (U.S. Geological Survey [USGS], 1970a and 1970b). In the eastern part of the base, a low and nearly level marine terrace lies east of the bluff with elevations of approximately 5 feet or less above msl, constituting the former Chevalier Field and Magazine Point areas.

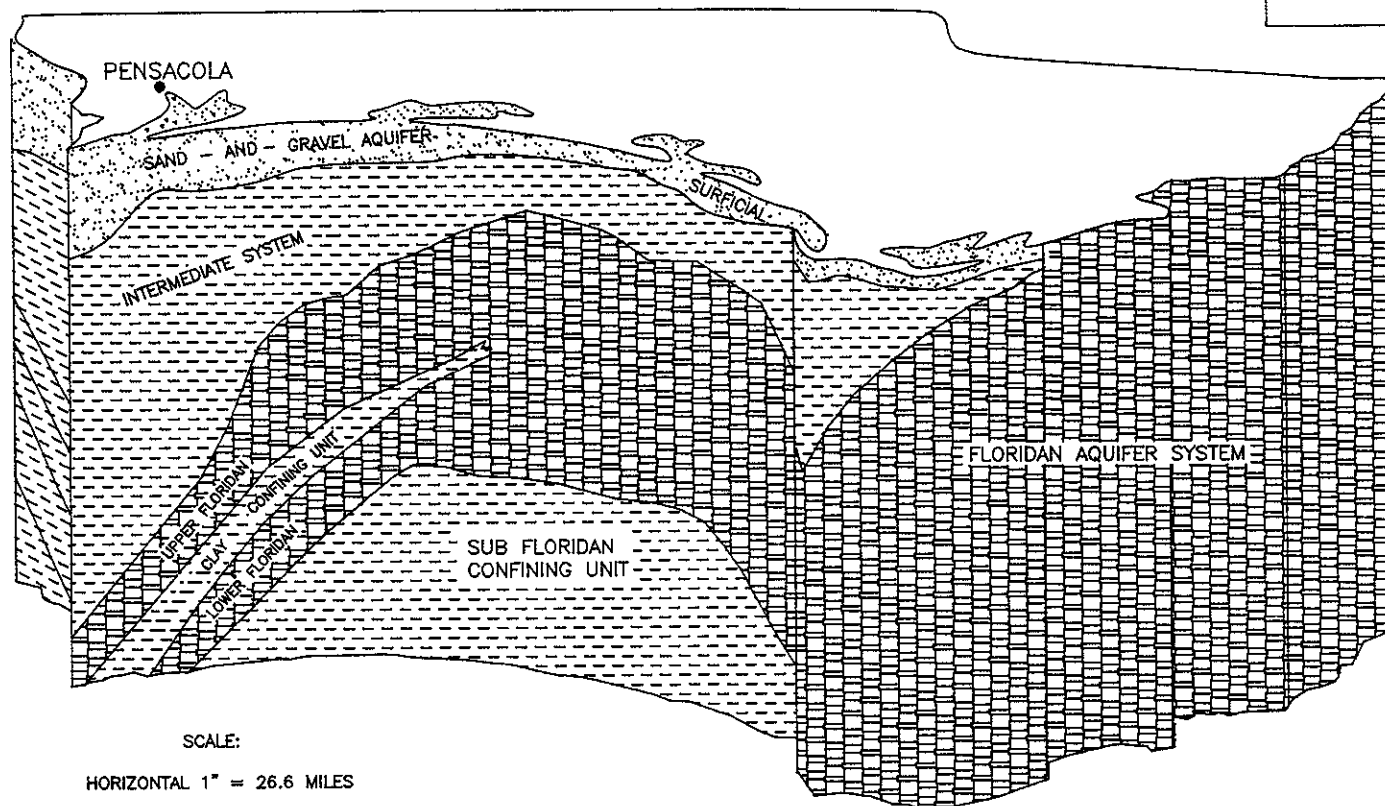
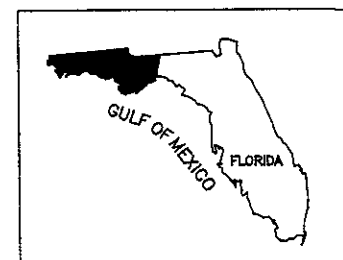
Sandy soils typify the NAS Pensacola area. Consequently, most rainfall infiltrates directly into the subsurface, resulting in few natural streams. Streams on base generally are man-made and channelized. Numerous natural wetlands occur in low-lying areas.

1.2.2 Stratigraphy and Hydrogeology

Stratigraphy beneath the Florida Panhandle generally consists of Quaternary marine terrace and fluvial deposits, underlain by a thick sequence of interlayered fine-grained clastic deposits and carbonate strata of Tertiary age (Southeastern Geological Society [SEGS], 1986). Three main regional hydrogeologic units have been described within this stratigraphic column (in descending order): the Surficial/Sand-and-Gravel Aquifer, the Intermediate System, and the Floridan Aquifer System. Figure 1-3 provides a generalized cross-section of these hydrogeologic units in northwest Florida.

Surficial/Sand-and-Gravel Aquifer

The Surficial Aquifer, composed primarily of unconsolidated siliciclastic sediments, is approximately 300 feet thick at NAS Pensacola. These sediments belong to undifferentiated Pleistocene-Holocene terrace deposits, the Pliocene Citronelle formation, and underlying Miocene



SCALE:

HORIZONTAL 1" = 26.6 MILES

VERTICAL 1" = 500 FEET

VERTICAL EXAGGERATION = 281



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FIGURE 1-3
GENERALIZED GEOLOGIC CROSS SECTION OF
HYDROGEOLOGIC UNITS IN
NORTHWEST FLORIDA

DATE: 11/04/99

DWG NAME: 0059G028

SOURCE: E&E 1992c.

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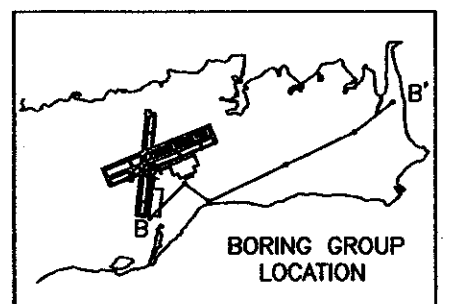
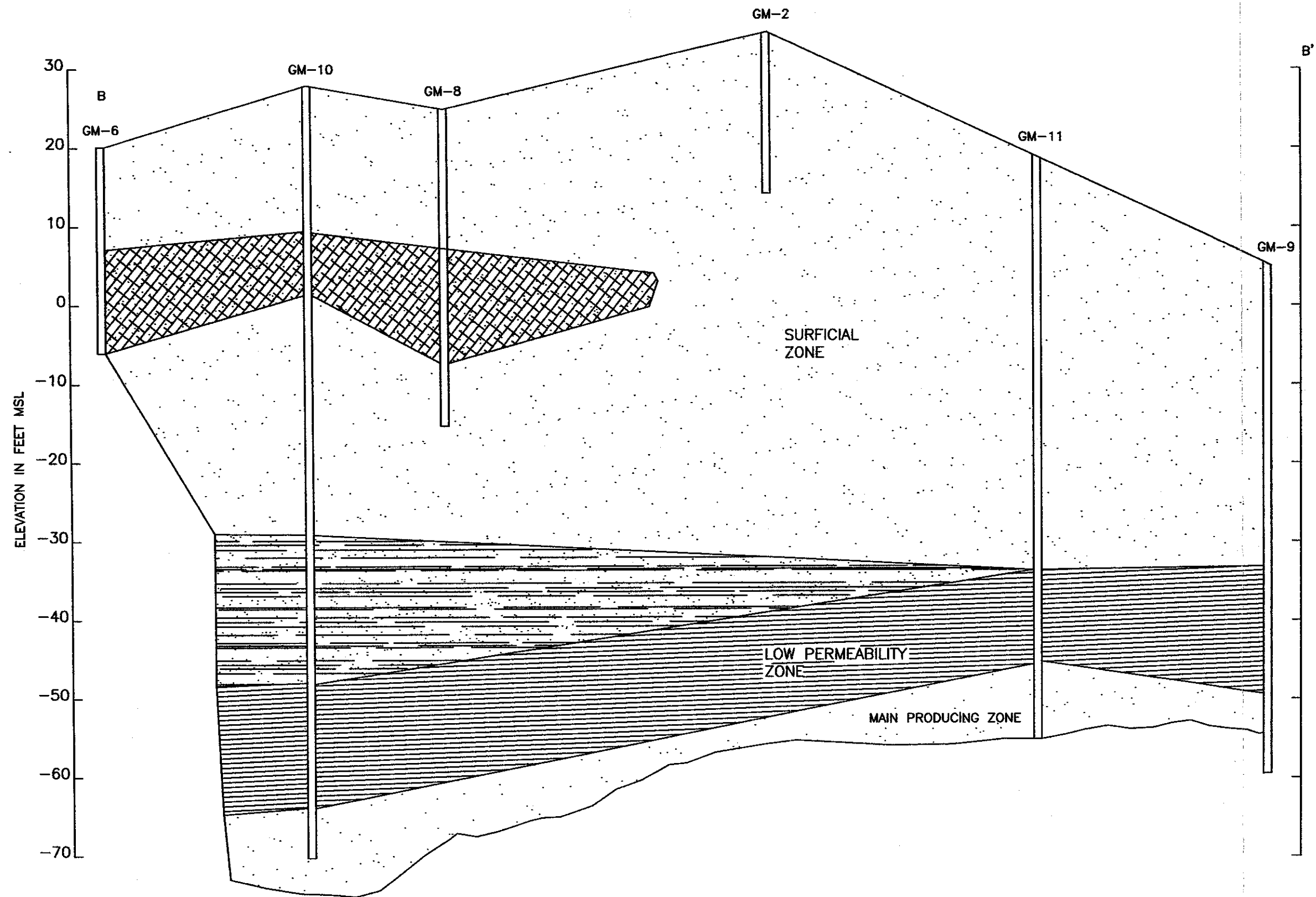
coarse clastics (Wilkins et al., 1985). West of the Choctawhatchee River in northwest Florida, the Surficial Aquifer is referred to as the Sand-and-Gravel Aquifer, and is a major source of drinking water (SEGS, 1986). The FDEP classification of the Surficial Aquifer is G-1, with a U.S. Environmental Protection Agency (USEPA) classification of IIA. Because the Sand-and-Gravel Aquifer is the uppermost unit contiguous with land surface and receives recharge through direct infiltration, it is susceptible to contamination from surface activities. Near NAS Pensacola, the unit has been subdivided into three distinct zones based on hydrogeologic differences (in descending order): the surficial zone, the low-permeability zone, and the main producing zone (Wilkins et al., 1985). This investigation focuses on the upper (shallow depth) and basal (intermediate depth) portions of the surficial zone. A generalized cross-section of the Sand-and-Gravel Aquifer produced by G&M (1984), as shown in Figure 1-4, illustrates the stratigraphic relationship of these zones.

Surficial Zone





The surficial zone is contiguous with land surface and contains groundwater under water table or perched conditions. At NAS Pensacola, the surficial zone is approximately 40 to 60 feet thick and is generally composed of a poorly graded quartz sand (G&M, 1984 and 1986). Beneath the western side of the base, a substantial stratum of sand with abundant organic matter occurs within the zone and pinches out to the east. Depth to groundwater ranges from 0 to 20 feet depending on ground surface elevation.

Aquifer tests have yielded high hydraulic conductivities, on the order of 10 to 100 feet/day (E&E, 1990). The lower contact with the low-permeability zone is transitional, resulting in a fining downward sequence in the lower portion of the surficial zone proper. Generally, the low-permeability zone is thicker to the west, and thins to the east. This increased clay content in the transition from the surficial to the low-permeability zone is responsible for lower hydraulic conductivities measured in the base of the surficial zone. Shallow groundwater flow in the surficial zone is generally influenced by topography, usually flowing toward and discharging to the nearest surface water body.

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LEGEND

-  SAND WITH ORGANIC MATTER
-  SAND
-  CLAYEY SAND
-  CLAY

SOURCE: GERAGHTY & MILLER, 1986



SITE 38
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NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 1-4
GEOLOGICAL CROSS SECTION
OF THE SURFICIAL AQUIFER
AT NAS PENSACOLA

DATE: 11/04/99

DWG NAME: 0059G034

Low-Permeability Zone

The low-permeability zone, which underlies the surficial zone, is characterized by clay and silt-sized sediments. At NAS Pensacola, this zone comprises gray to blue-gray sandy and silty marine clay with some shell fragments and clayey sands, with total thickness ranging from 8 to 40 feet (G&M, 1984 and 1986). The upper contact is transitional with the overlying surficial zone; however, the top of the low-permeability zone is marked by the first occurrence of a stiff blue-gray clay. Studies at NAS Pensacola indicate the low-permeability zone is continuous beneath the air station.

Hydraulic conductivities of the low-permeability zone are much lower than the overlying surficial zone, ranging between the orders of 0.0001 foot/day for clays and 1 foot/day for clayey sands (G&M, 1986). Hence, the low-permeability zone acts as a confining or semiconfining layer to inhibit groundwater flow between the overlying surficial and underlying main producing zones.

Main Producing Zone

The main producing zone underlies the low-permeability zone and constitutes the bottom portion of the Sand-and-Gravel Aquifer. Regionally, depth to the top of the zone ranges from 60 to 120 feet. The zone is composed of sand and gravel with thin beds of silt and clay, estimated to be approximately 300 feet thick at NAS Pensacola. Of the three zones in the Sand-and-Gravel Aquifer, this one is generally the most permeable and is the principal source of water supply for the Pensacola area (Wilkins et al., 1985). Groundwater in this zone is confined, being recharged in northern Escambia County where it is present at the surface. In the vicinity of NAS Pensacola, the main producing zone is supplemented by leakage. Regional groundwater flows generally east toward Pensacola Bay and south toward the Gulf of Mexico. Three supply wells at NAS Pensacola produce water from this zone. However, the water has a high iron and sulfur content and the wells are used only for irrigating the base golf course and for fire protection

(G&M, 1984 and 1986). For potable water, NAS Pensacola depends on an offsite source provided from main producing zone wells at Corry Field, approximately three miles to the north.

Intermediate System

The Intermediate System, a regionally and vertically extensive, laterally persistent hydrologic unit, underlies the Surficial/Sand-and-Gravel Aquifer. The system comprises fine-grained clastic units of Miocene age (Pensacola Clay, Alum Bluff Group) that lie beneath coarse clastics of the overlying Sand-and-Gravel Aquifer. In the NAS Pensacola vicinity, depth to the top of the unit is approximately 300 feet, with a thickness of approximately 1,100 feet (Wilkins et al., 1985; SEGS, 1986). The system is regionally characterized by poor to non-water-bearing conditions. Permeabilities are much lower than those of the overlying Sand-and-Gravel Aquifer and the underlying Floridan Aquifer System, and consequently the system functions as a confining unit for the underlying Floridan Aquifer System (SEGS, 1986).

Floridan Aquifer System

The Floridan Aquifer System underlies the Intermediate System at an approximate depth of 1,400 feet in the NAS Pensacola area. The unit is predominantly limestone, but is separated into upper and lower units by a significant clay layer called the Bucatunna Clay. Groundwater within the Floridan System is highly mineralized in the NAS Pensacola area and is not used for water supply (Wagner et al., 1984). However, groundwater from the Upper Floridan Aquifer is used for water supply approximately 25 miles east of NAS Pensacola.

1.2.3 Background Water Quality

As discussed in previous documents (*Site 1 Remedial Investigation Report*, E/A&H 1996b), wells were installed next to water supply wells to assess background water quality at NAS Pensacola. To assess overall background water quality, inorganic concentrations from these wells were compared to Florida Primary and Secondary Drinking Water Standards (FPDWS, FSDWS) as well

as criteria identified in Florida Administrative Code (FAC) 62-777. This comparison procedure is outlined in Florida's Underground Storage Tank (UST) (62-770) and Brownsfields (62-785) rules, which, if not applicable or relevant and appropriate requirements (ARARs), are To Be Considered (TBC) criteria under CERCLA, as shown in Appendix A. The comparison of background data and inorganic standards is shown in Appendix B, and is summarized in Table 1-1 below.

Table 1-1
NAS Pensacola Background Well Data versus Florida Standards

Element	Mean Background Concentration ($\mu\text{g/L}$)	Reference Concentration ($\mu\text{g/L}$)	Florida Standard ($\mu\text{g/L}$)	
Aluminum	1,941.38	3,882.76	200	Secondary
Iron	853.9	1,707.8	300	Secondary

Note:

$\mu\text{g/L}$ = micrograms per liter

Clearly, mean aluminum and iron concentrations are significantly above state standards.

It is important to note that these data were collected from background locations completed in the upland portion of NAS Pensacola and indicate water quality in areas not impacted by former industrial operations. Additional exceedances are consistently noted at sites located on the marine terrace downgradient of the uplands; manganese in particular is characteristic of marine terrace groundwater. Because groundwater in the surficial unit does not meet minimum standards for water quality at background locations, it is important to note that Site 38's proximity to Pensacola Bay decreases the likelihood of use as a potable water source. Several locations at Site 38 exceeded the FDEP primary standard for sodium of 160,000 micrograms per liter ($\mu\text{g/L}$). Groundwater extraction at Site 38 may induce saline intrusion, further degrading water quality and reducing its potential for domestic or potable use.

1.2.4 Area Climate

The Pensacola area has a mild, subtropical climate with average annual temperature ranging from 55°F in the winter to 81°F in the summer. Daily temperatures can be more extreme, from below 7°F in the winter to above 102°F in the summer. Thunderstorms, which occur on approximately half the summer days, can cause a precipitous temperature drop of 10° to 20°F in a matter of minutes (E&E, 1992c).

November is the driest month of the year with an average rainfall of 3.2 inches, based on climatological data from 1962 to 1991. Rainfall averages approximately 60 inches a year, with the highest amounts in July and August when thunderstorms occur almost daily. Thunderstorms commonly produce 3 to 4 inches of rain per hour. Rainfall is lowest during spring and fall (4 inches average per month), when rains are generally less intense, last longer, and produce less surface runoff. Higher rates of infiltration and net recharge, however, characterize spring and fall rainfall events (E&E, 1992c).

Winds, which prevail from the north during the winter and the south during the summer, are generally moderate in velocity except during thunderstorms. A difference in the ocean-land temperature produces the sea-breeze effect, a daily clockwise rotation in the surface wind direction near the coast. Hurricanes and tornadoes can substantially damage the nearshore environment. Since 1980, nine hurricanes have passed within 50 miles of Pensacola, including Hurricanes Erin and Opal in August and October 1995, respectively, and the most recent, Hurricane Georges in 1998.

1.3 Geological and Hydrogeological Results

Soil and groundwater data were collected to develop an understanding of the site stratigraphy and hydrologic system for the FS and, if necessary, the remedial design. Soil boring logs were used to describe the site stratigraphy; aquifer tests and tidal influence studies were used to assess the

surficial aquifer's hydraulic characteristics. In addition, soil and groundwater samples were submitted for laboratory analysis of physical characteristics and chemical properties. This information was used to assess contaminant fate and transport, and to evaluate possible remedial actions.

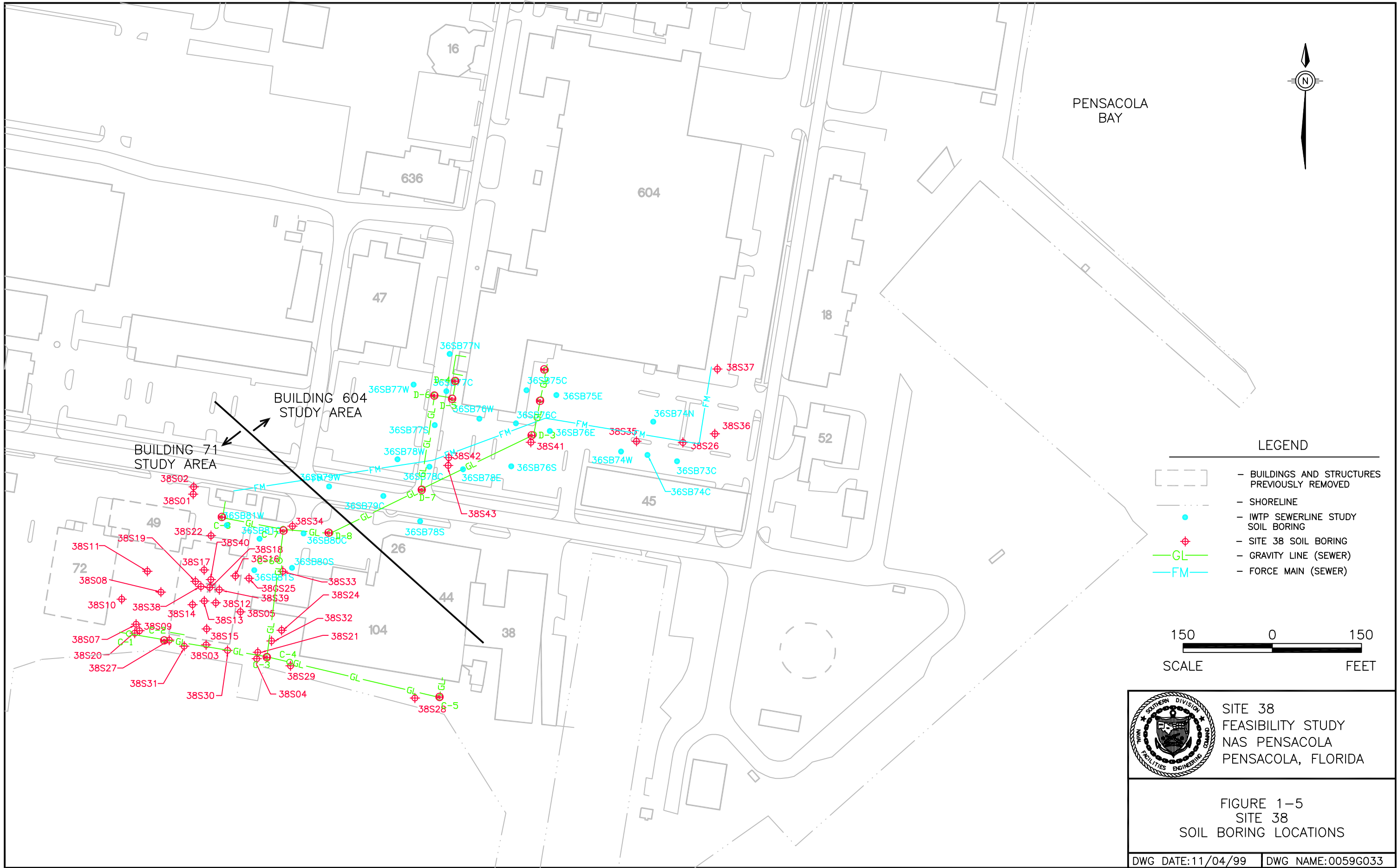
Soil boring and groundwater monitoring well locations at Site 38 are shown on Figures 1- 5 and 1-6, respectively.

1.3.1 Surficial Soil Zone Assessment

Sixty-seven soil borings were advanced during the RI, including 41 into the unsaturated zone to collect soil samples, 20 in the upper part of the surficial zone to install permanent or temporary shallow monitoring wells, and six to the base of the surficial zone to install intermediate monitoring wells. Stratigraphic information was generated on boring logs, and soil samples were submitted for analyses of select physical and chemical soil properties.

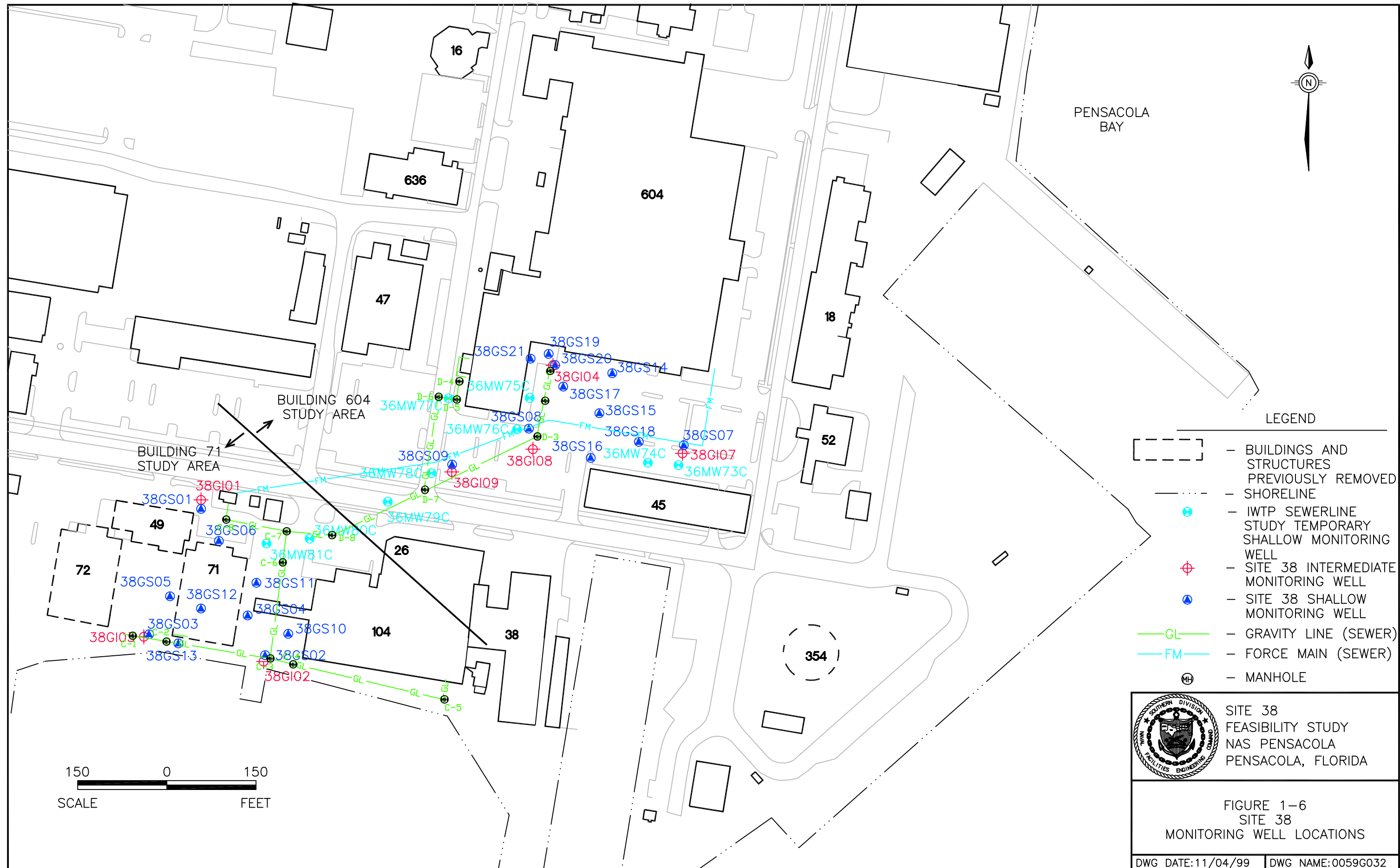
The stratigraphy is consistent with other findings at NAS Pensacola. The surficial zone is a fine- to medium-grained quartz sand and is 30 to 45 feet thick. The bottom 2 to 12 feet of the surficial zone grades into finer-grained sand, silts and clays in a "transition zone." Below the surficial/transition zone, is a dense, dark greenish-gray clay layer which is estimated to be approximately 12 to 17 feet thick in the NAS Pensacola area. This clay layer was encountered at each intermediate well location, suggesting that it is laterally continuous beneath the site. Figures 1-7 and 1-8 show geologic cross sections through the Building 71 and sewer line area, respectively.

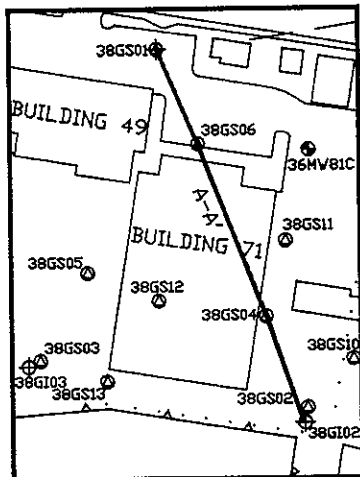
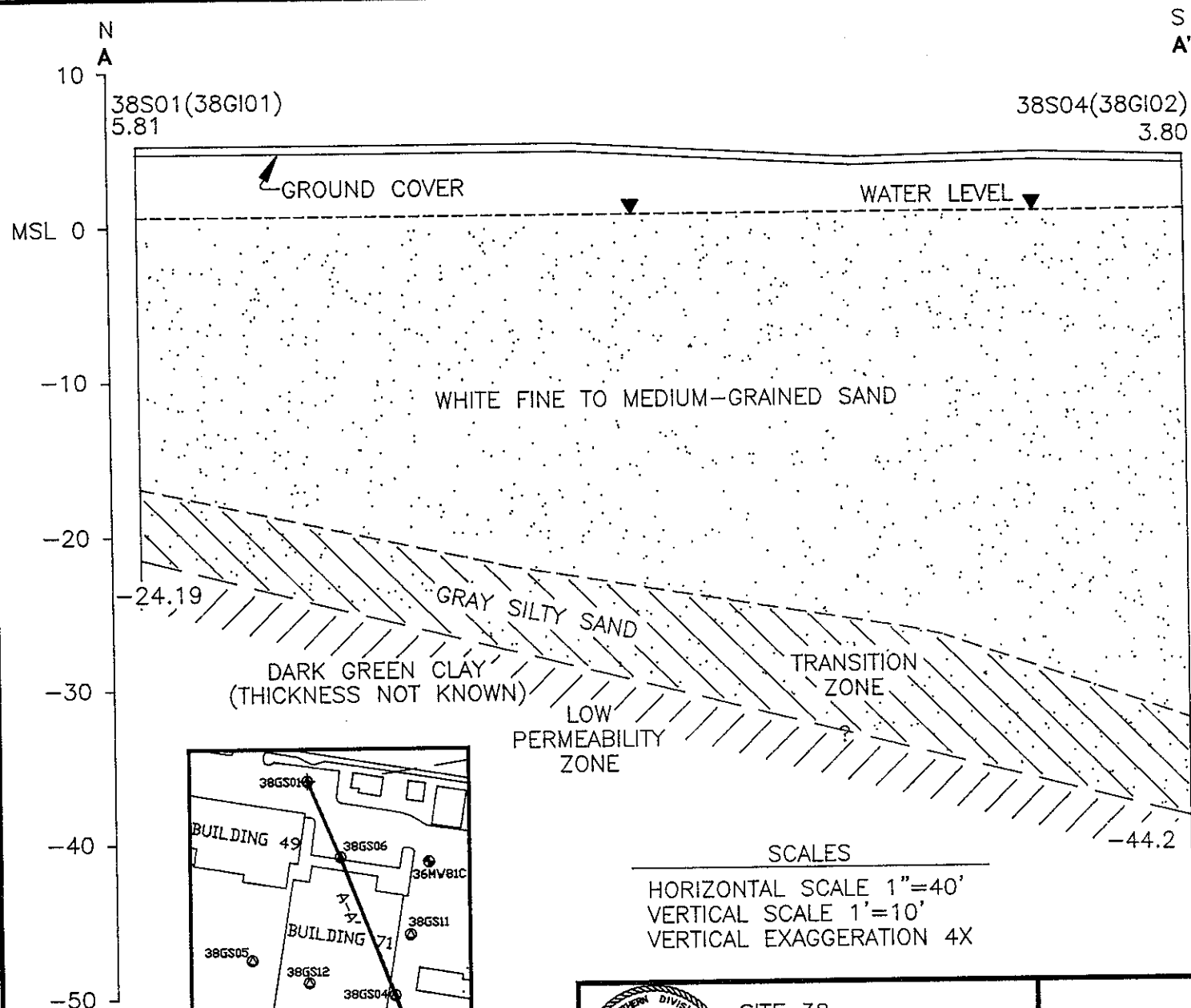
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SITE 38
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PENSACOLA, FLORIDA

FIGURE 1-5
SITE 38
SOIL BORING LOCATIONS





SCALES
 HORIZONTAL SCALE 1"=40'
 VERTICAL SCALE 1'=10'
 VERTICAL EXAGGERATION 4X

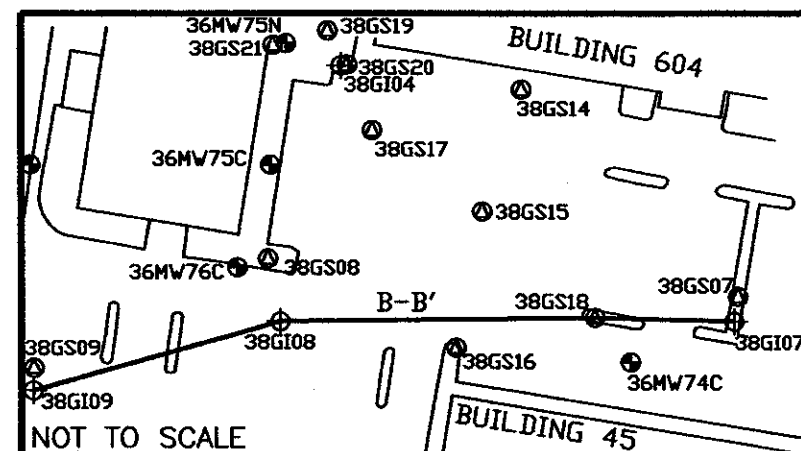
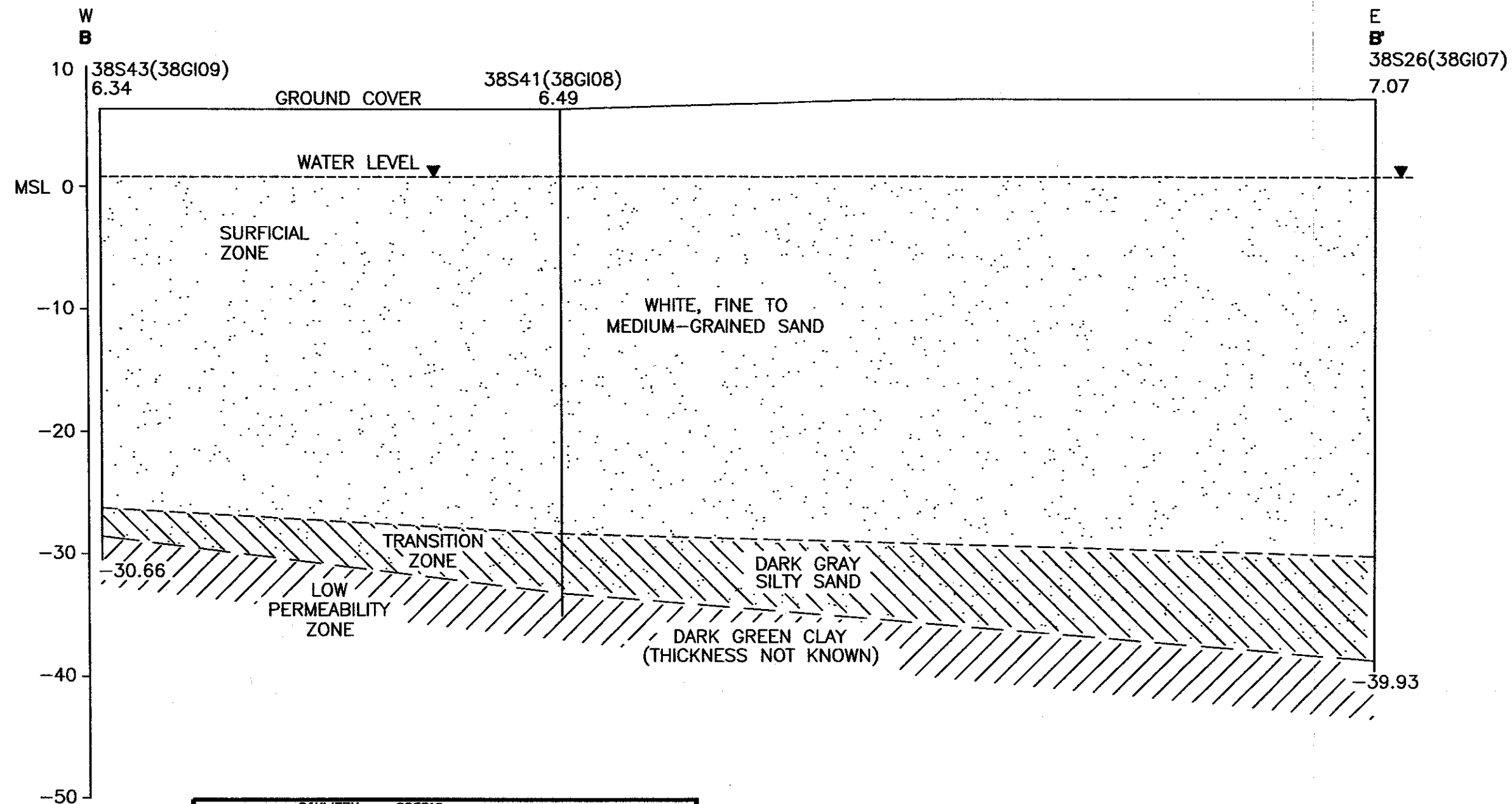


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FIGURE 1-7
 GEOLOGIC CROSS-SECTION A-A'
 BUILDING 71

DWG DATE: 11/04/99 | DWG NAME: 0059G029

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SCALES
 HORIZONTAL SCALE 1"=40'
 VERTICAL SCALE 1'=10'
 VERTICAL EXAGGERATION 4X



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FIGURE 1-8
 GEOLOGIC CROSS-SECTION B-B'
 IWTP AREA

Physical Parameters

Laboratory analysis of Shelby tube samples indicate the soil's vertical permeability decreases with depth from 1.934×10^{-2} cm/sec (54.82 ft/day) near the surface, to 4.784×10^{-3} cm/sec (13.56 ft/day) in the transition zone to the lowest value of 1.036×10^{-8} cm/sec (2.937E-05 ft/day) for the clay layer. Fetter (1988) classifies a unit with a permeability less than 1×10^{-5} cm/sec as an aquitard. Soil physical results are shown in Table 1-2.

Table 1-2
 Soil Physical Properties

Sample # (Boring)	Soil Zone	Sample Depth (Feet)	Percent Porosity	Specific Gravity	Vertical Permeability cm/sec ^a (ft/day)	USCS Classification
36S75C02 (36S75C) ^b	UZ	0 to 2	42.02	2.649	1.934e-02 (54.82)	Medium to fine sand, trace gravel (SP)
36S73N02 (36S73N) ^b	UZ	0 to 2	39.87	2.649	2.438e-3 (6.91)	Coarse to fine sand, trace gravel (SP-SM)
38GI09 (38S43) ^b	TZ	35 to 37	54.07	2.603	4.784e-3 (13.56)	Silty fine sand (SM)
38S09B1 (38S20) ^b	TZ/CL	45 to 47	57.82	2.599	1.167e-4 (0.31)	Medium to fine sandy lean clay (CL)
38GI07 (38S26) ^b	CL	45 to 47	70.50	2.468	1.036e-8 (2.937e-5)	Lean clay (CL)

Notes:

- a = cm/sec are multiplied by 2,835 to calculate ft/day.
- b = Numbers in parentheses are the laboratory report sample identification.
- Soil Zones = unsaturated zone (UZ), transition zone (TZ), and clay layer (CL).
- USCS = Unified Soil Classification System
- SP = Fine sand, trace gravel
- SM = Silty sand
- CL = Lean clay

Select soil chemical properties were determined by laboratory analyses including total organic carbon (TOC), cation exchange capacity (CEC), total kjeldahl nitrogen (TKN), nitrate, total phosphorus, and heterotrophic plate count; these data are summarized in Table 1-3, below. These data were collected for use in the FS and, if necessary, a remedial design.

Table 1-3
 Soil Chemical Properties

Parameter Sample ID	CEC meq/100g	TOC mg/kg	TKN mg/kg	Nitrate mg/kg	Phosphorus mg/kg	Heterotrophic Plate Count No/g
Data from Remedial Investigation						
38S0303	1.30	710	ND	3.3	ND	3,100,000
38S1103	0.72	ND	ND	ND	ND	3,700,000
38S1803	7.00	2,100	410	ND	170	1,600,000
38S2203	4.90	ND	74	ND	20	2,100,000
38S3001	0.38	94	ND	2.0	ND	260,000
38S3101	0.87	220	ND	3.1	12	170,000
38S3301	2.60	460	180	5.2	120	420,000
38S3401	4.40	450	56	4.3	140	210,000
38S3501	9.50	1,200	330	2.0	160	3,200,000
38S3601	3.20	540	59	ND	150	40,000
38S3701	7.00	550	250	ND	210	3,300,000
Data from February 1993 Study						
36S81W02	7.60	630	98	15.0	160	150,000
36S79C02	4.50	940	250	16.0	140	2,100,000
36S76W02	4.30	400	75	4.5	71	90,000
36S75E04	19.00	1,700	2,900	110.0	160	600,000

Notes:

CEC = Reported in milliequivalents per 100 grams
 ND = Not detected above sample detection limit
 No/g = number of colonies per gram

1.3.2 Surficial Aquifer Assessment

Thirty-seven monitoring wells were used during the RI, including nine temporary wells, 21 shallow wells, and seven intermediate wells. Groundwater samples were collected and analyzed for water quality and chemical properties. Specific capacity pumping tests and field measurements were conducted to assess aquifer properties.

Groundwater Quality

Select groundwater chemical properties were determined by laboratory analyses including five-day biological oxygen demand (BOD), chemical oxygen demand (COD), alkalinity, total suspended solids (TSS), hardness, TKN, nitrate, total phosphorus, and heterotrophic plate count, as shown in Table 1-4, below. These data were collected for use in the FS and, if necessary, a remedial design.

Table 1-4
Groundwater Chemical Properties

Sample ID Parameter	38GI01	38GS03	38GS09	38GS15
Alkalinity (mg/L)	250	140	88	120
TSS (mg/L)	82	290	140	39
Hardness (mg/L)	180	120	79	120
5-day BOD (mg/L)	4.4	1.6	ND	3.2
COD (mg/L)	38	160	30	35
TKN-N (mg/L)	1.6	0.41	ND	0.23
Nitrate-N (mg/L)	0.10	ND	0.11	ND
Phosphorus (mg/L)	0.35	0.62	0.47	0.054
Std. Plate Ct (No./ml)	46,000	5,700	8,900	4,700

Aquifer Characteristics

Specific capacity, transmissivity, and hydraulic conductivity values were estimated for the surficial aquifer by entering data from specific capacity pumping test into a computer program. Specific capacities range from 3.93 to 18.19 gpm/ft, transmissivities range from 624 to 13,614 ft²/day, and hydraulic conductivities range at intermediate depths from 16 to 124 ft/day, and at shallow depths range from 84 to 340 ft/day. Aquifer test results are shown on a well-specific basis in Table 1-5.

Table 1-5
 Aquifer Characteristics

Well ID	Specific Capacity (gpm/ft)	Transmissivity (ft ² /day)	Hydraulic Conductivity (ft/day)
Shallow Monitoring Wells			
38GS01	3.93	3,370	84
38GS14	9.44	7,208	180
38GS13	17.78	13,614	340
38GS11	14.64	11,285	282
38GS08	11.53	8,844	221
38GS07	12.83	9,858	246
38GS03	18.19	13,288	332
Intermediate Monitoring Wells			
38GI09	5.44	3,001	75
38GI07	1.49	790	20
38GI03	1.18	624	16
38GI01	8.85	4,955	124

Potentiometric Surface Data

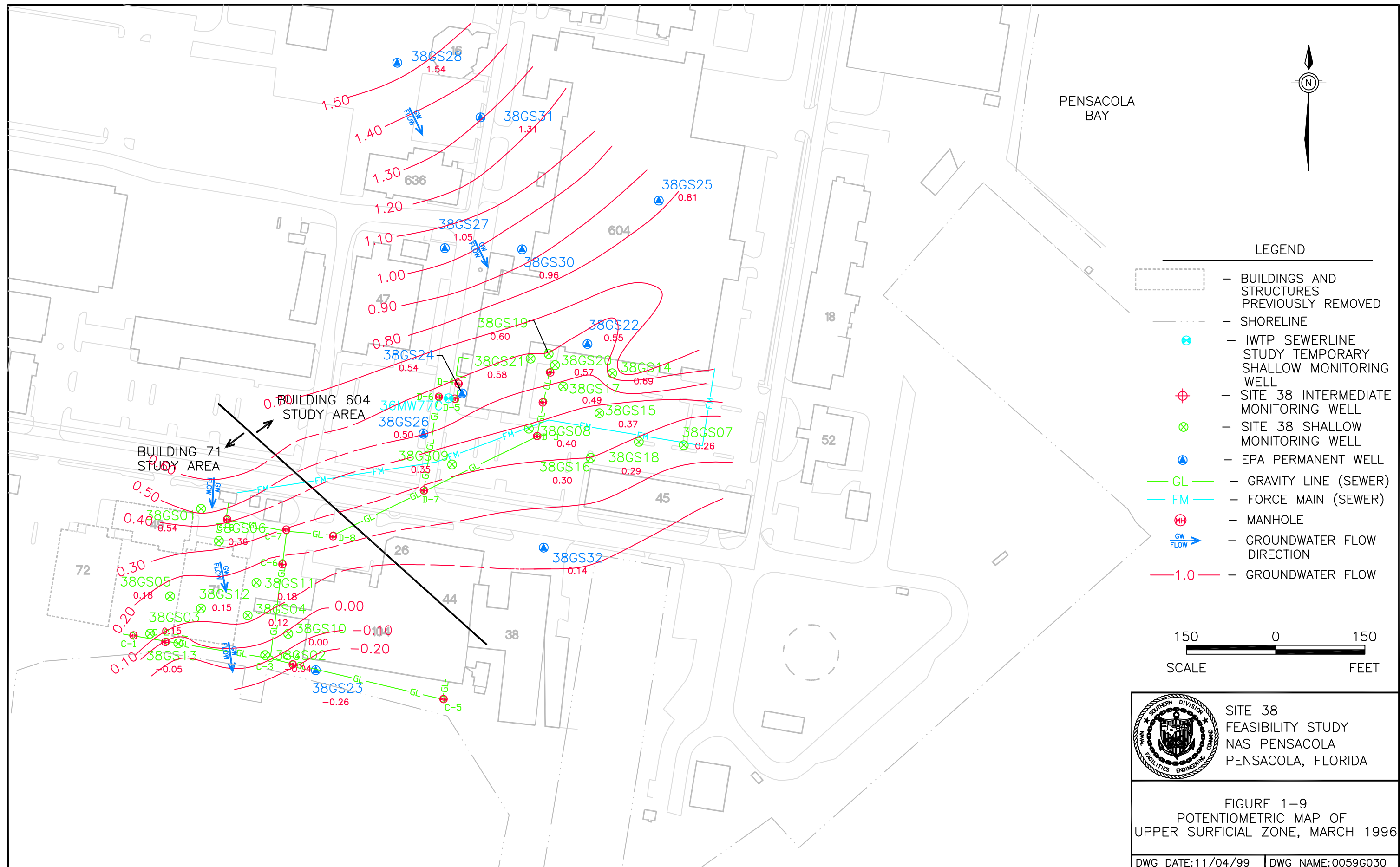
Potentiometric data were used to estimate groundwater flow directions, flow velocities, and vertical and horizontal flow gradients. Figure 1-9 shows the surficial zone potentiometric surface for March 1996. Shallow groundwater flows south-southeast with an estimated velocity ranging from 1.38 to 3.18 ft/day. Groundwater at the intermediate depth flows south with an estimated velocity ranging from 0.10 to 0.61 ft/day. Horizontal gradients were similar at the shallow and intermediate depth, ranging from 0.0006 to 0.0027. The maximum and minimum estimated vertical gradients were -0.0119 and 0.0008, respectively. In general, the potential for vertical flow appears to be downward (positive) across most of the site. However, there is a limited area between the bay and well location 38GI01, where negative vertical gradients were observed, indicating potential upward flow.

Tidal Study

A tidal study was completed to assess the effect of tidal changes on the potentiometric surface of the surficial zone. A time lag was observed between the tidal peak and the water level peak in wells, also, the magnitude of change in water level decreased inland. Well 38GS03 is approximately 53 feet inland and had an observed time lag of 4.5 hours and a change in water level of 0.421 feet, while at well 38GS01, approximately 240 feet inland, the observed time lag was eight hours with a change in water level of 0.184 feet.

A second part of the tidal study involved monitoring the hourly change in water level in select wells over nine hours. Monitoring began at 8 a.m., approximately 24 minutes before high tide on August 18, 1994. Potentiometric maps were generated for 9 a.m., noon, and 3 p.m. The general shape of the potentiometric surface remained the same, suggesting minimal changes in general flow direction or flow gradients. However, local changes were observed in the flow direction and flow gradients in nearshore wells, suggesting short-term reversals of flow direction in response to tidal peaks.

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1.4 Nature and Extent and Baseline Risk Assessment Summary

In the RI, all compounds detected in soil and groundwater were compared with various screening criteria or preliminary remedial goals (PRGs) to determine potential risk to human health and the environment. Screening parameters are described below.

Soil

- Risk-based concentrations (RBCs), soil ingestion scenario for residential soil (surface soil), and soil screening levels (SSLs), transfer scenario from soil to groundwater (subsurface soil) (USEPA, 1996a).
- Selected Cleanup Goals (CGs), residential scenario (surface soil) and leaching scenario (subsurface soil) (FDEP, 1995 and 1996).
- USEPA, Office of Solid Waste and Emergency Response draft revised Interim Soil Lead Guidance (USEPA, 1994).

Groundwater

- Maximum Contaminant Levels (MCLs) (USEPA 1996b).
- Tap Water RBCs (USEPA, 1996a).
- FPDWS (FDEP 1994a).
- USEPA Secondary Maximum Contaminant Levels (SMCLs) (USEPA 1996b).
- FSDWS (FDEP 1994a).
- Florida Groundwater Guidance Concentrations (FGGC) (FDEP 1994a).

Sediment

- Sediment Screening Values (SSVs) (USEPA, 1995).
- Sediment Quality Assessment Guidelines (SQAGs), Threshold Effects Levels (TELs) (FDEP, 1994b).

Soil and groundwater inorganics were compared with NAS Pensacola-specific reference concentrations (RCs), developed by the Navy during the Site 1 investigation. These are equal to twice the detected mean for any given parameter (E/A&H, 1996). The RCs can be found in Appendix B.

1.4.1 Summary of Soil Contamination at Site 38

Surface soil contaminants detected in the Building 71 study area above PRGs included inorganics, semivolatile organic compounds (SVOCs), pesticides, and polychlorinated biphenyls (PCBs). No volatile organic compounds (VOCs) were detected above PRGs in surface soil. Inorganic contamination was observed in the soil beneath Building 71 with contamination diminishing with distance from the building. Organic parameter exceedances in surface soil at Building 71 were very limited. Pesticide and PCB exceedances were limited to two locations beneath Building 71. The pesticide exceedances are likely a result of pretreatment during building construction. SVOC exceedances were associated with samples along the IWTP line with no exceedances in the soil beneath Building 71.

Subsurface soil contained inorganics, SVOCs, pesticides, and VOCs at concentrations exceeding PRGs or RCs. Again, much of the contamination appeared to be centered beneath Building 71. Inorganic and pesticide exceedances were consistent with exceedances in surface soil. SVOC and VOC exceedances were extensive in subsurface soil beneath Building 71 when compared to the leachability PRGs. Notably, no surface soil SVOC and VOC exceedances occurred in this area. In general, the contaminants present include heavy metals, chlorinated solvents, and petroleum

solvents potentially related to the past activities of paint stripping and metal refinishing at Building 71. Soil in the Building 71 study area is completely covered with concrete or asphalt.

Building 604 study area surface soil exceedances included inorganics, SVOCs, pesticides, and PCBs. Many of the inorganic parameters, including aluminum, arsenic, and iron, were fairly ubiquitous across the site and may indicate, in part, local ambient concentrations. Heavy metals related to past plating activities exceeded PRGs in the surface soil surrounding the former plating facility at the southwest extension of Building 604. SVOC contaminant exceedances were primarily associated with the IWTP line except for one location beneath the southern part of Building 604. Parts cleaning took place in the general vicinity of this sample. Pesticide and PCB exceedances occurred in samples from grassy areas onsite. Pesticide detections in these areas are likely the result of residuals remaining from routine spraying.

Subsurface contaminants detected at Building 604 above PRGs included inorganics, SVOCs, pesticides, and VOCs. Heavy metals, including chromium and cadmium, were detected above RCs and PRGs near the former plating facility. SVOC exceedances included PAHs at one location along the IWTP line. Dieldrin was the only pesticide detected. Its occurrence is likely a result of routine application of pesticides in the area. Two VOCs, TCE and tetrachloroethene, were detected above PRGs. Both of these detections are associated with solvent exceedances in the groundwater and may reflect inadvertent sampling of the capillary zone and not true soil contamination.

1.4.2 Summary of Groundwater Contamination at Site 38

Contaminants detected above a PRG in shallow groundwater in the Building 71 study area included inorganics, SVOCs, and VOCs. No pesticides or PCBs were detected above a PRG. Detected heavy metals potentially related to past paint stripping and metal refinishing processes included cadmium, chromium, and lead. These elements exceeded RCs and PRGs in wells 38GS05 and

38GS12 in the southwest part of the study area beneath former Building 71 and in downgradient well 39GS13. Aluminum, iron, manganese, and lead exceedances were widespread across the site. Concentrations of these metals from well 38GS01, upgradient of the site, were among the highest detected. The highest total inorganic concentrations were detected in the sample from well 38GS12, beneath former Building 71. Naphthalene was the only SVOC detected above a PRG. It exceeded the PRG in samples from wells 38GS12 and 38GS02. VOC contamination centered around the sample from 38GS12, beneath Building 71, and in downgradient locations along the seawall south and east of the former building. Total VOC concentrations for 38GS12 equaled 922 $\mu\text{g/L}$; concentrations in other wells diminished greatly downgradient. These VOCs included several halogenated aliphatic hydrocarbons and their presence is likely the result of past paint stripping and parts cleaning operations at Building 71.

Contaminants detected in the shallow groundwater were not detected above the PRGs in intermediate groundwater with the exception of aluminum, iron, sodium, and vanadium. Aluminum and iron appeared to be representative of ambient conditions; however, vanadium exceeded the PRG and RC in the three locations it was detected. The occurrence of these exceedances was consistent with exceedances in shallow groundwater. Sodium concentrations also exceeded the RC, however, this is most likely due to intrusion of saltwater from the bay.

Inorganics, SVOCs, and VOCs were also detected in the shallow groundwater in the Building 604 study area. Aluminum, iron, manganese, and lead were again fairly ubiquitous across the site at concentrations exceeding the PRGs; however, many of these exceedances were below their respective RCs. Heavy metals, including cadmium and chromium, were detected above PRGs surrounding the former plating shop and are likely a result of past plating operations. Naphthalene was detected above the PRG in the area and downgradient of the former solvent tank. Several PAHs also exceeded the PRG in the sample from well 36MW77C. This well is adjacent to the IWTP line. No exceedances were noted in surrounding and/or downgradient wells. Several

halogenated aliphatic hydrocarbons, including tetrachloroethene, TCE, and vinyl chloride, were detected above the PRG. The area most highly impacted was in the vicinity of the former solvent UST east of the former plating shop. Total VOC concentrations reached a maximum of 4,324 $\mu\text{g/L}$ in the sample from well 38GS17. VOC concentrations appeared to diminish in samples farther downgradient to the south and east. Two other areas where VOCs exceedances occurred were at a temporary well adjacent to Building 636 and north of the Port Operations, Building 38. Tetrachloroethene was detected in a well east of Building 636, a former dry cleaning facility. This dry cleaning operation may likely be the source of the tetrachloroethene. No surrounding wells had detections above the PRG. The other VOC detection was in a well north of Building 38. This well is adjacent to the storm drain system leading from Building 604. Historically, solvent and metal waste were discharged through this system to the bay. Possible leaks to this system may be responsible for the detections of chlorinated solvents in this well. In general, contamination in the Building 604 study areas centers around the former plating shop and former solvent UST areas and in downgradient areas to the southeast. Notably, contaminants were not detected in the temporary wells near the seawall downgradient of the site.

Contaminants detected above a PRG and/or RC in the intermediate groundwater were aluminum, cadmium, chromium, and vinyl chloride.

Generally, the investigation of soil and groundwater at Site 38 has adequately assessed the nature and extent of contamination at Site 38.

After constituents were compared with these screening criteria, a BRA was performed on RI data for each site. BRA results are summarized below.

1.4.3 Shoreline Groundwater Compared to Marine Surface Water Criteria

The RI also performed a comparison of groundwater from wells directly adjacent to the shoreline to surface water criteria. The results of this comparison are presented in Table 1-6. The

contaminants listed may enter the marine environment due to groundwater to surface water discharge. In no way does this comparison represent the actual impact on surface water quality. As seen in Table 1-6, seven metals and three organic compounds detected in groundwater exceed a saltwater criteria for either USEPA or FDEP.

Table 1-6
 A Comparison of Shoreline Groundwater to Marine Surface Water Criteria

Parameter	Sample ID	Units	Result	FDEP Saltwater Criteria	USEPA Saltwater Criteria
Aluminum	38GS13	µg/L	2320.0	1500	
	38GS03	µg/L	2700.0		
	38GI03	µg/L	895.0 J		
	38GI02	µg/L	1090.0 J		
	38GS02	µg/L	1330.0		
Beryllium	38GI03	µg/L	1.2 J	0.13	0.13
Cadmium	38GS13	µg/L	11.0	9.3	
Chromium	38GS02	µg/L	11.1	103	673000
	38GI02	µg/L	11.0 J		
	38GS03	µg/L	74.8		
	38GS13	µg/L	184.0		
	38GS03	µg/L	70.6		
Copper	38GS13	µg/L	319.0	2.9	2.9
	38GS02	µg/L	311.0		
	38GS03	µg/L	45.6		
	38GI03	µg/L	8.5		
	38GI02	µg/L	12.5		
Iron	38GS03	µg/L	1250.0 J	300	
	38GS02	µg/L	7470.0		
	38GS03	µg/L	4930.0		
	38GS13	µg/L	4560.0		
	38GI02	µg/L	1570.0 J		

Table 1-6
 A Comparison of Shoreline Groundwater to Marine Surface Water Criteria

Parameter	Sample ID	Units	Result	FDEP Saltwater Criteria	USEPA Saltwater Criteria
Lead	38GS03	µg/L	88.5	5.6	
	38GS02	µg/L	362.0 J		
	38GS13	µg/L	158.0		
Zinc	38GS03	µg/L	819.0	86	
	38GS13	µg/L	684.0		
	38GS02	µg/L	133.0		
	38GI03	µg/L	17.0		
bis(2-Ethylhexyl)phthalate	38GI02	µg/L	142.0 J		
	38GI03	µg/L	1.0 J	0.3	
	38GI02	µg/L	1.0 J		
Naphthalene	38GS02	µg/L	44.0	23.5	
1,1-Dichloroethane	38GS13	µg/L	20.0	10.8	
		µg/L	44.0		

Notes:

J = Indicates a laboratory estimate.

Bold indicates an exceedance of the saltwater criteria.

1.4.4 Human Health Risk Assessment (HHRA) Summary

Risk and hazard were assessed for Site 38 by dividing the site into two study areas, Building 71 and Building 604. Soil exposure pathways included ingesting and directly contacting soil, while groundwater exposure pathways included ingesting and inhaling chemicals in groundwater. Uniform exposure was assumed for each exposure pathway. Hypothetical future site residents and workers were assessed for these pathways. The soil exposure pathway was also assessed for the adolescent site trespasser.

By using these scenarios to estimate exposure to chemicals reported in Site 38 media, several significant assumptions were made. Most soil sampled at Site 38 is beneath pavement, and if the

property assessed were developed for residential or commercial use, soil conditions would be expected to change. Base reuse plans for NAS Pensacola are updated every five years, and the base plans are currently being drafted for the upcoming five years. The future land use of Site 38 is unknown, but continued industrial/commercial use is expected. Soil conditions were assumed to be static, and exposure was considered to be uniform.

Soil

USEPA's acceptable risk range is $1E-6$ to $1E-4$, and FDEP's risk goal is $1E-6$. For the hypothetical exposure pathways included in this report, the site resident soil risk estimates for Building 71 and Building 604 are $1E-05$ and $5E-05$, respectively, assuming the soil exposure pathways will be completed. For site worker scenario, soil risk estimates for Building 71 and Building 604 are $2E-06$ and $9E-06$, respectively, again assuming the soil exposure pathways will be completed. Under both scenarios, hypothetical site resident site worker scenarios exceed FDEP's threshold. The primary contributors to soil risk at both sites are arsenic and benzo-(a)pyrene equivalents (BEQ). Consequently, chemicals of concern have been identified for the site residents and workers. Neither Building 71 nor Building 604 trespasser risk estimates exceed USEPA acceptable risk range.

Soil hazard estimates are less than the USEPA and FDEP threshold of 1.0 for site residents, site workers, or site trespassers. Therefore, chemicals of concern have not been identified for soil based on the hazard index (HI).

Groundwater

Drinking water is supplied by Corry Station, and the water-bearing zone beneath NAS Pensacola would not be expected to be used as a drinking water source. Assuming groundwater exposure pathways would be completed, risk estimates for both areas are shown below:

Table 1-7
 Groundwater Risk Summary

	Residential Scenario		Industrial Scenario	
	HI (child)	ILCR (adult)	HI (worker)	ILCR (adult)
Building 71	32.1	3E-03	4.8	8E-04
Building 604	99.9	1E-01	15.1	3E-02

Notes:

HI = Hazard Index
 ILCR = Incremental Lifetime Cancer Risk

As shown, under both residential and industrial use scenarios, USEPA and FDEP risk and hazard thresholds are exceeded. In groundwater near Building 71, arsenic and VOCs primarily account for risk and hazard estimates. However, the 95th percentile upper confidence limit, arithmetic mean, and geometric mean of the arsenic concentrations reported in groundwater did not exceed the MCL or FPDWS.

1.4.5 Potential Receptors

Site 38 has been an industrial area supporting supply, maintenance, and disposal activities for more than 40 years. The contaminants within Site 38 appear to be limited to surface and subsurface soil and the surficial aquifer. Current and potential receptors include:

- The surficial zone of the Sand-and-Gravel Aquifer, which is currently not in use due to taste and odor characteristics and its proximity to Pensacola Bay.

- The main producing zone of the Sand-and-Gravel Aquifer, used as a potable water source in Escambia County, which underlies the surficial zone but is separated from it by a confining clay unit.
- Pensacola Bay, which receives groundwater flow from Site 38.

The low-permeability clay layer between the surficial and main producing zones may inhibit any downward contaminant migration into the deeper groundwater below the clay. The coastal waters of surrounding NAS Pensacola have been classified by the FDEP as Class III, indicating their use for recreation and maintenance of a well-balanced fish and wildlife population.

1.4.6 RI Data Gaps and Recommendations

No data gaps were noted that require additional fieldwork or analysis to complete this investigation and provide the basis for the FS. The soil data offer sufficient analytical quantitation and distribution to assess the nature and extent of contamination. Soil exceedances due to metals, PCBs, and SVOCs represent a risk that will need to be addressed by the FS.

VOCs have been detected consistently in groundwater during multiple sampling events. Inorganics, however, were detected mainly during the first event: review of sampling techniques suggests that inorganics quantified during the initial site work (1993 and 1994) are attributable to high turbidity and suspended solids associated with bailer techniques. Subsequent sampling events, performed using quiescent sampling techniques, yielded significantly lower inorganic concentrations. VOCs are the primary focus of the feasibility study, but inorganic concentrations will be addressed where 1995 or 1998/1999 events indicated exceedances. However, it should be noted that 1995 and 1998/1999 events were limited in scope, and no comprehensive sampling event has been performed since the initial RI. Since no trend analysis is available site-wide, groundwater should be monitored quarterly before remedial design. The specific capacity used

to calculate hydraulic conductivity is a rough order of magnitude estimate and should be amended with pumping tests to provide information during remedial design. The current pairing and distribution of monitoring wells appear to offer sufficient coverage to monitor trends effectively. Lead contamination in groundwater near Building 71 may be associated with a secondary source west or northwest of the former Building 71 area. The lead source will be investigated and managed as a separate site.

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2.0 FEASIBILITY STUDY PROCESS

The overall objective of the CERCLA remedy selection process is to select remedies that are protective of human health and the environment, that maintain protection over time, and that minimize untreated waste. The RI is used to assess site conditions and the risk assessment process is used to assess risk and hazard based on RI findings. These data are used to gauge the magnitude of site risk and identify possible areas requiring feasibility study.

The FS process comprises the following elements:

- **Development of Remedial Action Objectives (RAOs) and Remedial Goals (RGs)**, including the definition of applicable or relevant and appropriate requirements (ARARs) and development of RAOs, delineation of areas which exceed RGs and require feasibility analysis, and associated impacted volumes.
- **Technology Screening**, including identification of remedial process options which address site contaminants, and evaluation against three basic screening criteria: implementability, effectiveness, and cost.
- **Assembly of Alternatives**, in which technologies deemed applicable to site conditions are assembled into viable remediation alternatives. A conceptual design is developed and evaluated again using the three basic screening criteria of implementability, effectiveness, and cost. This second screening process identifies advantages and disadvantages of each remedial approach.
- **Detailed Analysis of Alternatives**, including assessing each alternative against nine criteria specified in 40 Code of Federal Regulations (CFR) 430(e)(9)(iii) (the National Oil and Hazardous Substances Contingency Plan [NCP]). These criteria are used to evaluate

each alternative's overall protection of human health and the environment and compliance with statutory requirements.

- **Comparative Analysis of Alternatives**, which highlights the similarities and differences between the alternatives using the nine NCP criteria.

This section will outline the major elements of the FS process. Feasibility analysis will be performed for each impacted medium in the following sections:

- Section 3 — Groundwater Feasibility Evaluation
- Section 4 — Soil Feasibility Evaluation

2.1 Development of Remedial Action Objectives

The remedial alternatives selection process begins during RI planning, when PRGs are set, based on readily available information such as presence of chemical-specific ARARs. As the RI/FS proceeds, goals are modified as needed to reflect understanding of the site and its ARARs. Final remediation goals are established when the remedy is selected. The goals must establish acceptable exposure levels that are protective of human health and the environment, and must consider ARARs.

In developing remedial objectives for the FS, four issues were addressed:

- PRGs based on chemical-specific ARARs
- Spatial distribution of contamination in the media of concern, as determined by the RI

- Human health and ecological assessments, including exposure pathways, addressed in the BRA
- Potential groundwater contamination indicated by contaminant residuals in site soil

2.1.1 Chemical-Specific ARARs and To-Be-Considered Criteria (TBCs)

As per the NCP, remedial goals establish acceptable exposure levels that are protective of human health and the environment and are developed by considering the following:

- ARARs under federal environmental or state environmental or facility siting laws, if available, and the following factors:
 - For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effects during a lifetime or part of a lifetime, incorporating an adequate margin of safety.
 - For known or suspected carcinogens, acceptable exposure levels are generally concentrations that represent an excess upper bound lifetime cancer risk between $1E-06$ and $1E-04$. The $1E-06$ risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available or are not significantly protective due to the presence of multiple contaminants or exposure pathways.
 - Technical limitations, quantitation limits, uncertainties, etc.

- Non-zero maximum contaminant level goals (MCLGs), established under the Safe Drinking Water Act (SDWA), are relevant and appropriate for ground or surface waters that are current or potential drinking water sources. When MCLGs are set at zero, maximum contaminant levels (MCLs) shall be attained when relevant and appropriate to the circumstances of the release.
- In cases involving multiple contaminants or pathways where attainment of chemical-specific ARARs will result in cumulative risk in excess of 1E-04, risk- or technology-based goals may be developed.
- Water quality criteria established under the Clean Water Act (CWA) shall be attained where relevant and appropriate.
- Alternate concentration limits (ACLs) may be established in accordance with CERCLA Section 121(d)(2)(B)(ii).
- Environmental evaluations shall be performed to assess threats to the environment.

Chemical-specific ARARs will be considered in developing remedial objectives for the site.

A review of potential ARARs, shown in Appendix A, identified potential site remediation goals in Florida Rule 62-777. This rule is referenced by FAC 62-770 and 62-785, rules for UST and Brownsfields sites, respectively. Though not directly applicable to Site 38, these rules have been identified as To Be Considered criteria for remedial actions at NAS Pensacola due to similar site contaminants and end-use objectives. As discussed in FAC 62-777, soil goals may include:

- Residential soil cleanup target levels (RSCTLs), where land use will be unrestricted
- Industrial soil cleanup target levels (ISCTLs), where land use will be restricted to industrial or commercial/industrial uses
- Soil leaching criteria protective of groundwater criteria ("GC leach")
- Soil leaching criteria protective of marine surface water ("MSW leach")

Rule 62-777 identifies the following potential criteria for groundwater:

- FPDWS
- FSDWS
- Groundwater criteria protective of marine surface water (MSWQ)

Appendix C contains tables identifying all sample locations that exceed specific Florida criteria for groundwater; Appendix F contains similar tables for soil. As stated above, Appendix A lists chemical-, location-, and action-specific ARARs.

2.1.2 Definition of RAOs and RGs

RAOs are typically defined once the nature of site contaminants is known. In addition, current and future land use, adjacent property conditions, human health and ecological risk assessments, and other factors may be considered to identify a "reasonable future use" scenario. Identification of site COCs, as well as the future use scenario, enable decision-makers to develop site-specific RGs that are protective of human health and the environment, but which are not overly conservative given probable exposure scenarios.

2.1.3 Delineation of Areas Exceeding RGs

Once RAOs and RGs are defined, media exceeding RGs can be identified. At Site 38, the environmental media exceeding RGs are soil and groundwater. FDEP has required point-by-point compound-specific compliance with RGs; therefore constituents in each soil boring and groundwater monitoring well will be compared with RGs. Exceedances will be noted and the areas exceeding RGs will be defined.

2.1.4 Environmental Media Volumes Exceeding RGs

Where environmental media exceed RGs, volumes requiring remedial action will be estimated. These estimates will be developed using RI-generated data, and data gaps will be identified where volume estimates are uncertain. Accurate delineation of remedial volumes is critical to the selection of applicable remediation technologies, as well as development of reliable cost estimates.

2.2 Technology Screening

After impacted media volumes are defined, the next step in the FS process is identification of technologies applicable to site contaminants. Once technologies are identified, they are reviewed for effectiveness, implementability, and cost. Technologies are either eliminated or retained for further consideration. This screening is done on a media-specific basis for Site 38 because of the various contaminants identified and ongoing use requirements at the base.

2.2.1 CERCLA Response Actions

The NCP provides guidance for conducting the RI/FS and the process of remedy selection. The stated purpose of the selection process is to assure that implemented remedies protect human health and the environment by eliminating, reducing, and/or controlling risks posed through each pathway.

The goal of the FS process is to select remedies based on fundamental criteria including:

- Protection of human health and the environment
- Compliance with ARARs
- Minimization of untreated hazardous waste

2.2.2 Program Management Principles

Sites should be remediated in OUs when 1) reduction of significant risk must be accomplished quickly, 2) a phased analysis and response is necessary or appropriate given the size or complexity of the site, or 3) when the expected final remedy must be expedited. Interim responses should not be inconsistent with implementation of the expected final remedy, nor should they preclude it. Site-specific data needs, alternate evaluation, and documentation of the selected remedy should reflect the scope and complexity of the site problems being addressed.

2.2.3 Expectations

In the NCP, USEPA broadly categorizes remedial action alternatives into general response actions for consideration in the FS.

- **Treatment** — Use treatment to address the principal threats posed by a site, where practical.
- **Containment** — Use engineering controls such as containment for waste that poses a relatively low long-term threat, or where treatment is impractical.
- **Combination** — Use a combination of appropriate methods to protect human health and the environment.

- **Land Use Controls** — Use institutional controls such as water and deed restrictions to supplement engineering controls as appropriate for short- and long-term management to prevent or limit exposure to hazardous substances, pollutants, or contaminants. Institutional controls will not be substituted for active response measures as the sole remedy unless such active measures are determined to be impractical, based on the balance of tradeoffs among alternatives determined during remedy selection.
- **Innovative Technology** — Consider innovative technology when it offers the potential for comparable or better treatment, performance, or ease of implementation, less adverse impacts, or lower costs than demonstrated technologies.
- **Groundwater Restoration** — Restore usable groundwater to its beneficial uses whenever practical, in a reasonable amount of time. Where this cannot be accomplished, USEPA expects to prevent further migration of the plume, prevent exposure to the contaminated groundwater, and evaluate further risk reduction.

2.2.4 General Response Actions

General response actions are media-specific actions that can achieve RAOs alone or in combination with other actions. Remedial action alternative types include:

- **Source Control Actions:** Source control actions are a range of alternatives in which treatment is used to reduce the toxicity, mobility, or volume of the hazardous substances, pollutants, or contaminants. The range considered in an FS should include an alternative that removes or destroys these constituents of concern to the maximum extent feasible, eliminating or minimizing the need for long-term management. In addition, alternatives are to be considered which treat the principal threats posed by the site, but vary in the

degree of treatment and the amount and characteristics of residuals and untreated waste that must be managed.

- **Containment Actions:** One or more alternatives should be considered which protect human health and the environment primarily by preventing or controlling exposure to site contaminants through engineering or institutional controls. Examples include engineering controls such as extraction or injection wells and institutional controls such as deed or access restrictions.
- **Groundwater Response Actions:** A limited number of groundwater remediation actions should be assessed which attain site-specific goals within different restoration time periods. These alternatives should use one or more methods such as groundwater extraction, treatment and in-situ actions.

2.2.5 Identification of Technologies

This section provides general descriptions of technology types that may be applied to meet the response actions described above.

No Action/Limited Action

The NCP requires evaluation of a No Action alternative as a basis of comparison with other remedial alternatives. Because no action may result in contaminants remaining onsite, CERCLA, as amended, requires a review and evaluation of site conditions every five years if this alternative is selected.

Natural Attenuation

Natural attenuation refers to dilution, dispersion, advection, and biotic degradation of contaminants in the environment. Consideration of this option requires modeling and evaluation

of contaminant degradation rates and transport during remedial design. Sampling and sample analysis must be conducted throughout the process to confirm that attenuation is proceeding at rates which meet remediation objectives and to assure that no receptors are threatened.

Institutional Controls

Institutional controls reduce potential hazards by limiting public exposure, not by reducing volume, mobility, or toxicity of hazardous substances. Some examples of such responses are:

- Site access controls
- Public awareness and education
- Groundwater use restrictions
- Long-term monitoring
- Deed restrictions
- Warning against excavation and soil use

Removal/Excavation

Removal includes excavating soil and collecting groundwater. Soil is excavated with heavy equipment. Collection of groundwater is achieved with subsurface drains (interceptor trenches/french drains) or groundwater extraction wells.

Containment

Groundwater is contained by installing a network of extraction wells or subsurface drains to produce a hydraulic barrier and eliminate or reduce the migration of groundwater. Vertical barriers such as slurry walls, high density polyethylene (HDPE) sheeting or sheet piling may also be used to reduce horizontal transport of contaminants in groundwater from the contaminated soil zones.

A surface cap of asphalt, concrete, clay, or synthetic membranes indirectly provides containment by minimizing contaminant transport through soil caused by percolation of precipitation. These containment options can be used alone or in combination to isolate contaminated soil and/or groundwater.

Treatment

Groundwater treatment technologies are varied, and include carbon adsorption, biological treatment, coagulation, precipitation, solids separation, stripping, oxidation/reduction, or photolysis. Soils may be treated by multiple technologies such as ex-situ biological degradation, low-temperature thermal desorption, incineration, or chemical/physical processes such as soil washing, solidification, or stabilization.

Discharge/Disposal

Groundwater may be treated and discharged to the Federally-owned treatment works (FOTW), treated and discharged to surface water, or reinjected into the aquifer. Excavated soil may be disposed offsite at a hazardous or nonhazardous waste landfill, used as site fill material, or isolated in an onsite containment unit.

2.2.6 Preliminary Technology Screening

In the following sections, treatment technologies are presented for groundwater and soil at Site 38.

After treatment technologies are defined, their objectives, implementability, effectiveness, and cost are discussed in terms of site specifics. The screening tables are consistent with technology screening techniques presented in the NCP and USEPA guidance because they include containment, removal, disposal, and treatment options. The three screening criteria applied to these technology options are implementability, effectiveness, and cost.

- Implementability encompasses both the technical and administrative feasibility of putting a technology into effect. Technical implementability is used to initially eliminate technology types and process options that are clearly ineffective or unworkable. The readily available information from the RI site characterization is used to screen out such methods. Administrative implementability emphasizes the institutional aspects of a remedy, such as the ability to obtain necessary permits for offsite actions; the availability of treatment, storage, and disposal services (including capacity); and the availability of necessary equipment and skilled workers to implement the technology.
- The effectiveness screening evaluation is based on how well each technology would protect human health and the environment. Each should be evaluated for its effectiveness in providing protection and reducing toxicity, mobility, or volume of contaminants. Both short and long-term components of effectiveness should be evaluated; short-term refers to the construction and implementation period and long-term refers to the period after the remedial action is complete.
- Costs play a limited role in the screening process. Relative capital and operation and maintenance (O&M) costs are used rather than detailed estimates. At this stage in the process, the cost analysis is based on engineering judgment, and each process is evaluated according to whether costs are high, low, or medium relative to other process options.

Following screening, technologies are either retained for assembly into alternatives or discarded. The rationale for discarding technologies is presented in each section.

2.3 Assembly of Alternatives

Following identification and screening of technologies, general response actions and process options are combined to form alternatives that address the entire site. These process options were

chosen as representatives of technology types. In assembling alternatives, the NCP goal of evaluating a range of alternatives was considered. Where possible given the size of the site and the extent of RG exceedances, the alternatives vary in level of effort, balance of containment versus treatment measures, cost, and remediation time frame. Alternatives have been developed to respond separately to remedial needs for groundwater and soil.

Definitions of each alternative should provide sufficient information to distinguish the alternatives with respect to effectiveness, implementability, and cost. The following information should be included in each definition:

- Locations of areas to be excavated or contained.
- Approximate volumes of soil and/or groundwater to be managed.
- Size and configuration of onsite extraction and treatment systems or containment structures.
- Approximate locations of wells, trenches, treatment systems, etc.
- Management options for treatment residuals.
- For media with several hazardous constituents, it may be necessary to identify which contaminant(s) impose the greatest treatment requirements.
- Remediation time frame.
- Rates or flows of treatment.

- Spatial requirements for treatment or containment actions.
- Distances for disposal actions.
- Required permits for offsite actions and imposed limitations.

In short, the alternative description should include enough information to adequately explain the alternative and document the logic behind the proposed action.

After development, each alternative is screened again using the three general criteria of implementability, effectiveness, and cost.

- Implementability measures both the technical and administrative feasibility of constructing, operating, and maintaining an alternative. Technical feasibility refers to the ability to construct, operate, and meet ARARs, and includes an assessment of O&M and monitoring. Administrative feasibility refers to interactions with other agencies, availability of treatment, and any specific or unusual requirements.
- Effectiveness is evaluated through an assessment of how each alternative provides protection and the degree to which it reduces toxicity, mobility, or volume. Short-term effectiveness is evaluated according to the implementation period; long-term effectiveness assesses conditions after the remedial action is completed.
- Costs are assessed in greater detail at this stage than in the initial technology screening. A variety of cost-estimating data are considered to develop both capital and O&M costs.

2.4 Detailed Analysis of Alternatives

Once identified, remedial alternatives are evaluated with respect to the requirements stipulated in CERCLA as amended, the NCP (40 CFR 300.430), OSWER Directive Number 9355.9-19 (*Superfund Selection of Remedy*, Interim, December 24, 1986), and factors described in OSWER Directive Number 9355.3-01 (*Conducting Remedial Investigations and Feasibility Studies Under CERCLA*, Interim Final, October 1988).

2.4.1 Evaluation Process

The detailed analysis of alternatives entails analyzing and presenting relevant information for decision-makers to select a site remedy; it is not intended to replace the decision-making process. During the detailed analysis, each alternative is assessed against the evaluation criteria described in the OSWER Directive Number 9355.3-01 and all other alternatives. The results of the assessment are arrayed to compare the alternatives and identify key tradeoffs among them. This approach to analyzing alternatives is designed to provide decision-makers with sufficient information to adequately compare the alternatives, select an appropriate site remedy, and demonstrate satisfaction of the CERCLA remedy selection requirements of the remedial action decision.

Nine evaluation criteria have been developed to address the CERCLA requirements and considerations, and to address the additional technical and policy considerations that have proven important for selecting among remedial alternatives. These evaluation criteria serve as the basis for conducting the detailed analysis during the FS and for subsequently selecting an appropriate remedial action.

Evaluation Criteria

- Overall protection of human health and the environment
- Compliance with ARARs

- Short-term effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, or volume
- Implementability
- Cost
- State acceptance
- Community acceptance

Each alternative is evaluated according to the above criteria, as described in the following sections. At the completion of all detailed analyses, a section is included in which the statutory factors and criteria listed above are compared for each alternative to assist in selecting a remedy.

2.4.2 Threshold Criteria

Alternatives must meet two threshold criteria to be considered in the FS: overall protection of human health and the environment, and compliance with ARARs.

Overall Protection of Human Health and the Environment

This criterion provides a final check of the alternative's ability to protect human health and the environment. The overall assessment of protection draws on the assessments conducted under other evaluation criteria, especially long-term effectiveness and permanence, short-term effectiveness, and compliance with ARARs.

This evaluation step should focus on whether the alternative adequately eliminates, reduces, or controls the risk posed by each pathway through treatment, engineering, or institutional controls. This evaluation also considers whether an alternative poses any unacceptable short-term or cross-media impacts.

Compliance with ARARs

This criterion determines whether each alternative will meet all federal and state ARARs. The detailed analysis should identify which requirements are applicable or relevant and appropriate to an alternative, including chemical-, location-, and action-specific ARARs. The actual determination of which requirements are applicable or relevant and appropriate is made by the lead agency (the Navy) in consultation with the support agencies (USEPA and FDEP). Appendix A presents the ARARs for Site 38.

2.4.3 Balancing Criteria

Five balancing criteria highlight technical and administrative distinctions between each alternative. These five criteria include short-term effectiveness; long-term effectiveness; reduction of toxicity, mobility, or volume; implementability; and cost.

Short-Term Effectiveness

Short-term effectiveness addresses the effect of the alternative on human health and the environment during implementation, as determined by:

- Risks to the community.
- Risks to workers.
- Potential for adverse environmental impact.
- Time until remedial response objectives are achieved.

Long-Term Effectiveness and Permanence

This criterion addresses the risk remaining onsite after response objectives have been met. The primary focus in this step is the extent and effectiveness of the controls that may be required to manage the risk posed by treatment residuals and/or untreated wastes.

The following should be addressed for each alternative:

- **Magnitude of Residual Risk:** This factor assesses risk remaining from untreated waste or treatment residuals at the conclusion of remedial activities. The potential for this risk may be measured by numerical standards such as cancer risk levels or the volume or concentration of contaminants in waste, media, or treatment residuals.
- **Adequacy and Reliability of Controls:** This factor assesses the adequacy and suitability of any controls that are used to manage treatment residuals or untreated wastes remaining onsite. This may include an assessment of containment systems and institutional controls to determine if they are sufficient to ensure that any exposure to human and environmental receptors is within protective levels.

Reduction of Toxicity, Mobility, or Volume

This criterion addresses the statutory preference for remedies that employ treatment technologies which permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances. The evaluation should consider the following specific factors:

- Treatment processes, the remedies they will employ, and the materials they will treat.
- Amount of hazardous materials that will be destroyed or treated, including how principal threat(s) will be addressed.
- Degree of expected reduction in toxicity, mobility, or volume, measured as a percentage of reduction (or order of magnitude) when possible.
- Degree to which the treatment will be irreversible.

- Type and quantity of treatment residuals that will remain following treatment.
- Whether the alternative would satisfy the statutory preference for treatment as a principal element.

Implementability

Implementability addresses the technical and administrative feasibility of implementing an alternative and the availability of various services and materials required to do so. Technical feasibility should consider:

- **Construction and Operation:** This factor assesses the technical difficulties and unknowns associated with constructing and operating a technology.
- **Reliability of Technology:** The likelihood that technical problems during implementation will lead to schedule delays.
- **Ease of Undertaking Remedial Actions:** Future remedial actions that may need to be undertaken and the difficulty in implementing them.
- **Monitoring Considerations:** The ability to monitor the effectiveness of the remedy, including evaluating exposure risks if monitoring is insufficient to detect a system failure.

The administrative feasibility of each alternative should also be considered, including all activities needed to coordinate with other offices and agencies.

- **Offsite Treatment:** Availability of adequate offsite treatment, storage capacity, and disposal services.

- **Equipment and Specialists:** Availability of necessary equipment and specialists, and provisions to ensure any necessary additional resources.
- **Services and Materials:** Availability of services and materials, plus the potential for obtaining competitive bids, which may be particularly important for innovative technologies.
- **Prospective Technologies:** Availability of prospective technologies.

Cost

Detailed cost estimates for each remedial alternative are based on engineering analyses, suppliers' estimates of necessary technology, and costs for similar actions (such as excavation) at other CERCLA and Resource Conservation and Recovery Act (RCRA) sites. This is one of the primary balancing criteria on which the detailed analysis is based. The cost estimate for a remedial alternative includes capital cost, O&M costs, and present-worth analysis.

- **Capital Costs:** These typically include direct costs for equipment, labor, and materials used to develop, construct, and implement a remedial action. They also include indirect costs for engineering, financial, and other services that are not actually part of construction, but are required to implement the alternative. The percentage applied to the direct cost varies with the degree of difficulty associated with construction and/or implementation of the alternative. In this FS, indirect costs include health and safety items, permitting and legal fees, bid and scope contingencies, engineering design and services, and other miscellaneous supplies or costs.
- **Annual O&M Costs:** These are post-construction costs necessary to ensure the continued effectiveness of a remedial action. They typically refer to long-term power and material

costs (such as the operational cost of a water treatment facility), equipment replacement costs, and long-term monitoring and reporting costs.

- **Present-Worth Analysis:** This allows for comparison of remedial alternatives on the basis of a single cost representing an amount that, if invested in the base year and disbursed as needed, would be sufficient to cover all costs associated with the remedial action during its planned life. A performance period appropriate to each alternative is assumed for present-worth analyses. Discount rates of 6% are assumed for base calculations. An increase in the discount rate decreases the present worth of the alternative.

Cost elements for each remedial alternative are summarized in the cost analysis section. Study estimate costs are intended to reflect actual costs with an accuracy of minus 30% to plus 50%, in accordance with USEPA guidelines.

2.4.4 Modifying Criteria

Two modifying criteria, state and community acceptance, are used to evaluate the public's response to each alternative.

USEPA/State Acceptance

This assessment evaluates the technical and administrative issues and concerns USEPA and FDEP may have regarding each alternative. This criterion is largely satisfied through federal and state involvement in the remedial process, including review of the FS. The U.S. Navy, the lead agency, will work with USEPA and FDEP to implement the chosen alternative.

Community Acceptance

This assessment evaluates issues and concerns the public may have regarding each of the alternatives. As with state acceptance, this criterion will be addressed in the Record of Decision (ROD) when comments on the FS have been received.

2.5 Comparative Analysis of Alternatives

Once the alternatives have been fully described and individually assessed against the nine criteria, the relative performance of each is evaluated. The purpose of the comparative analysis is to identify the advantages and disadvantages of each alternative in relation to one another. This section should highlight differences between alternatives as they meet each of the criteria, especially the balancing criteria. This focus should help determine which options are cost-effective and which remedy utilizes permanent solutions and treatment to the maximum extent practicable.

3.0 GROUNDWATER FEASIBILITY EVALUATION

As described in Section 2, groundwater concentrations have been compared to groundwater and surface water cleanup target levels (CTL) as promulgated in Florida Administrative Code 62-777 to determine the volume of groundwater impacted by former industrial operations at Site 38. Once exceedances were identified, they were evaluated to assess the likelihood of a widespread groundwater plume or a persistent mass which could pose a risk to human health or the environment. These evaluations were used to develop the remedial approach to groundwater at Site 38, including remediation strategies.

3.1 Nature and Extent of Contamination

The nature and extent of groundwater contamination has been evaluated by comparing data to CTLs. However, naturally occurring inorganic compounds in the shallow aquifer have been detected in background samples at concentrations that would indicate poor quality groundwater (i.e., it is not a likely source of *usable* drinking water). As such, primary (sodium) and secondary inorganic compounds (aluminum, calcium, copper, iron, magnesium, manganese, vanadium, and zinc) that exceeded FPDWS and FSDWS criteria were excluded from groundwater exceedance evaluations since their concentrations are typical of natural conditions. While these compounds may affect remedial technology selection and design, they are not considered significant environmental concerns.

Multiple sampling events were conducted at the Site 38 complex; in most cases, these data show a decline in contaminant concentrations. For illustrative purposes, this FS presents data from the 1993/1994 (original RI), 1995, 1998, and 1999 sampling events. Screening-level data such as that generated by the mobile laboratory during EPA sampling were omitted from the evaluation. Final data were used to develop remedial volumes. For clarity, the final data set identified for each well and used in the groundwater volume delineation is presented in each evaluation table.

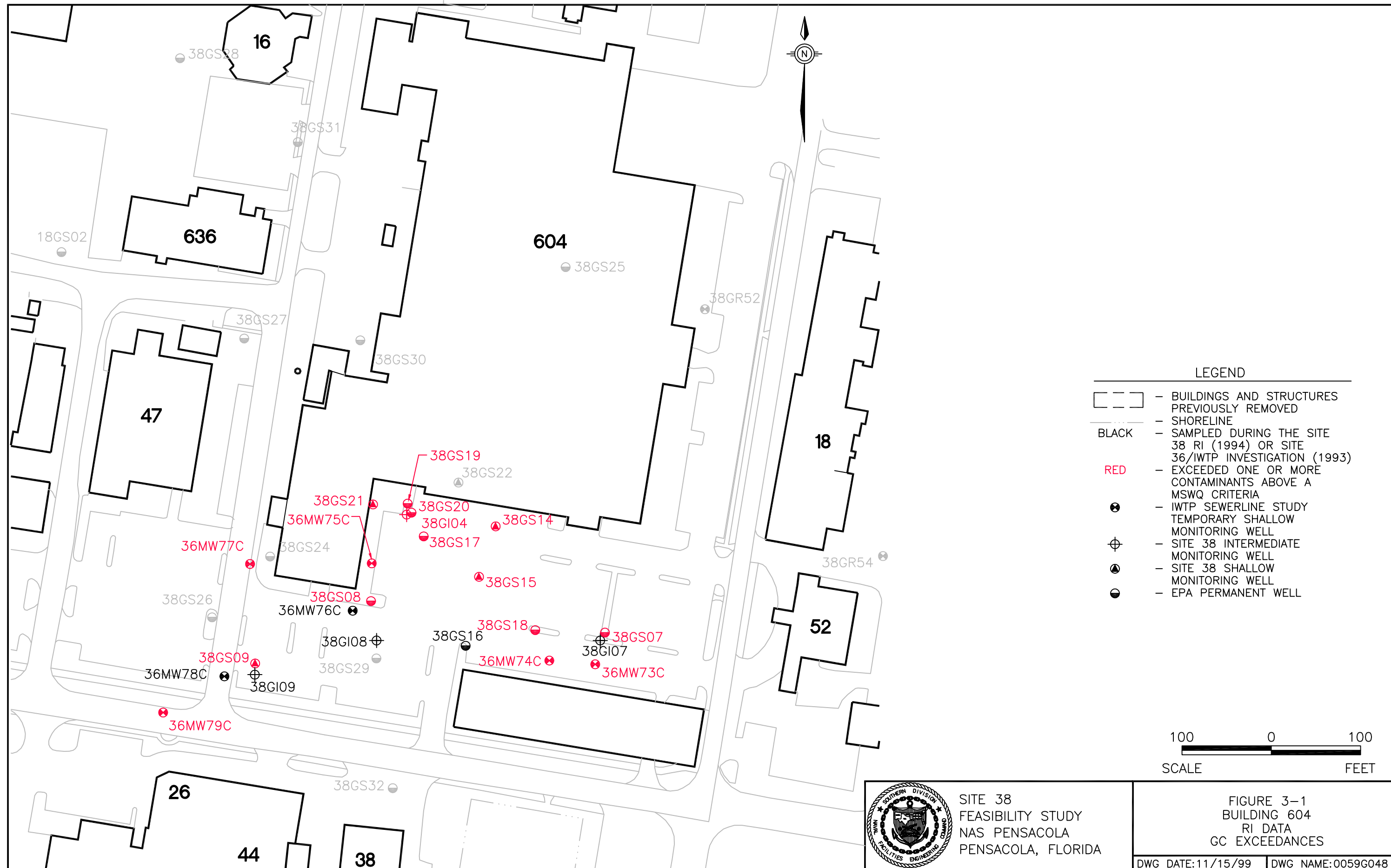
Exceedances at Site 38 are presented by parameter and are compared to General Criteria (GC) and Marine Surface Water Quality (MSWQ) criteria in Appendix C. Only wells exceeding screening criteria are shown in the following sections.

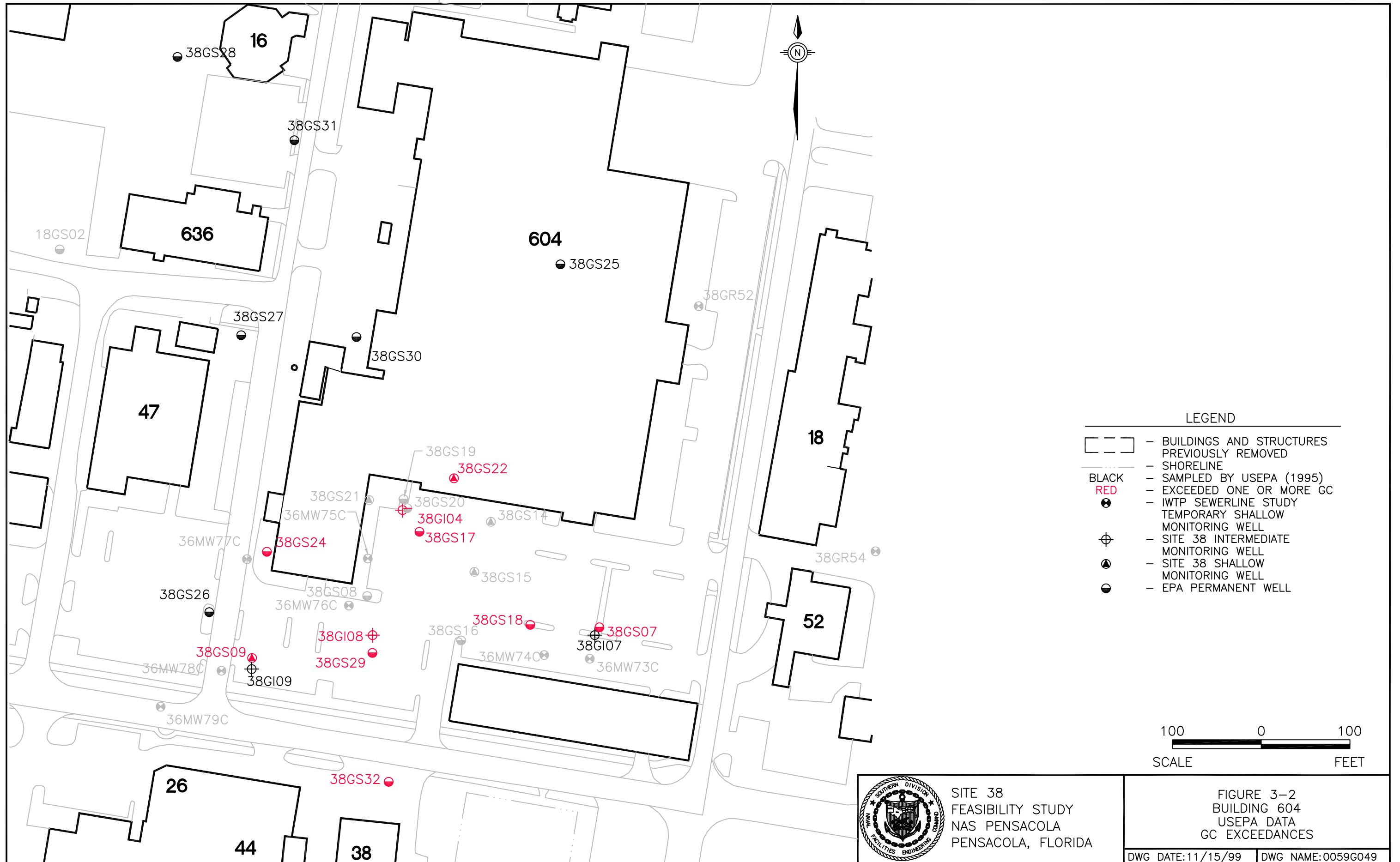
3.1.1 Building 604

3.1.1.1 Comparison to General Criteria

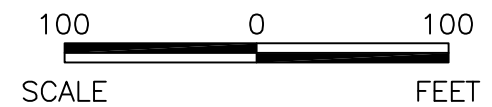
Groundwater data from the Building 604 area were compared to GC, those wells having values exceeding a GC are presented in Table 3-1, and exceedances are presented on Figures 3-1, 3-2, and 3-3 for RI data, EPA data, and 1998/1999 data, respectively. Groundwater contamination in the Building 604 area is fairly widespread from the southern end of Building 604 to just south of South Avenue. Contamination consists of VOCs, antimony, lead, cadmium, chromium, and some isolated SVOCs.

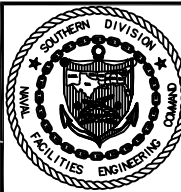
Concentrations of total VOCs (TVOCs) were elevated during the RI, with a maximum TVOC concentration of 1,604 $\mu\text{g/L}$ in 38GS17; concentrations had decreased significantly in many impacted wells by the 1999 sampling event. For example, TVOCs in well 38GS22 have decreased from 4,310 $\mu\text{g/L}$ (1995) to non-detect (1999) and in well 38GS32 concentrations have gone from 2,620 $\mu\text{g/L}$ (1995) to 49 $\mu\text{g/L}$ (1998), effecting a 98 % removal rate. VOC decreases since the RI are expected to be attributable to natural attenuation processes, which were discussed in the 1999 *Draft Technical Memorandum: Evaluation of Monitored Natural Attenuation* (EnSafe, 1999). These processes will be discussed further in Alternative G2: Monitored Natural Attenuation.





- LEGEND
- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
 - SHORELINE
 - BLACK - SAMPLED BY USEPA (1995)
 - RED - EXCEEDED ONE OR MORE GC
 - ⊗ - IWTP SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
 - ⊕ - SITE 38 INTERMEDIATE MONITORING WELL
 - ⊙ - SITE 38 SHALLOW MONITORING WELL
 - - EPA PERMANENT WELL



	SITE 38 FEASIBILITY STUDY NAS PENSACOLA PENSACOLA, FLORIDA	FIGURE 3-2 BUILDING 604 USEPA DATA GC EXCEEDANCES	
		DWG DATE: 11/15/99	DWG NAME: 0059G049

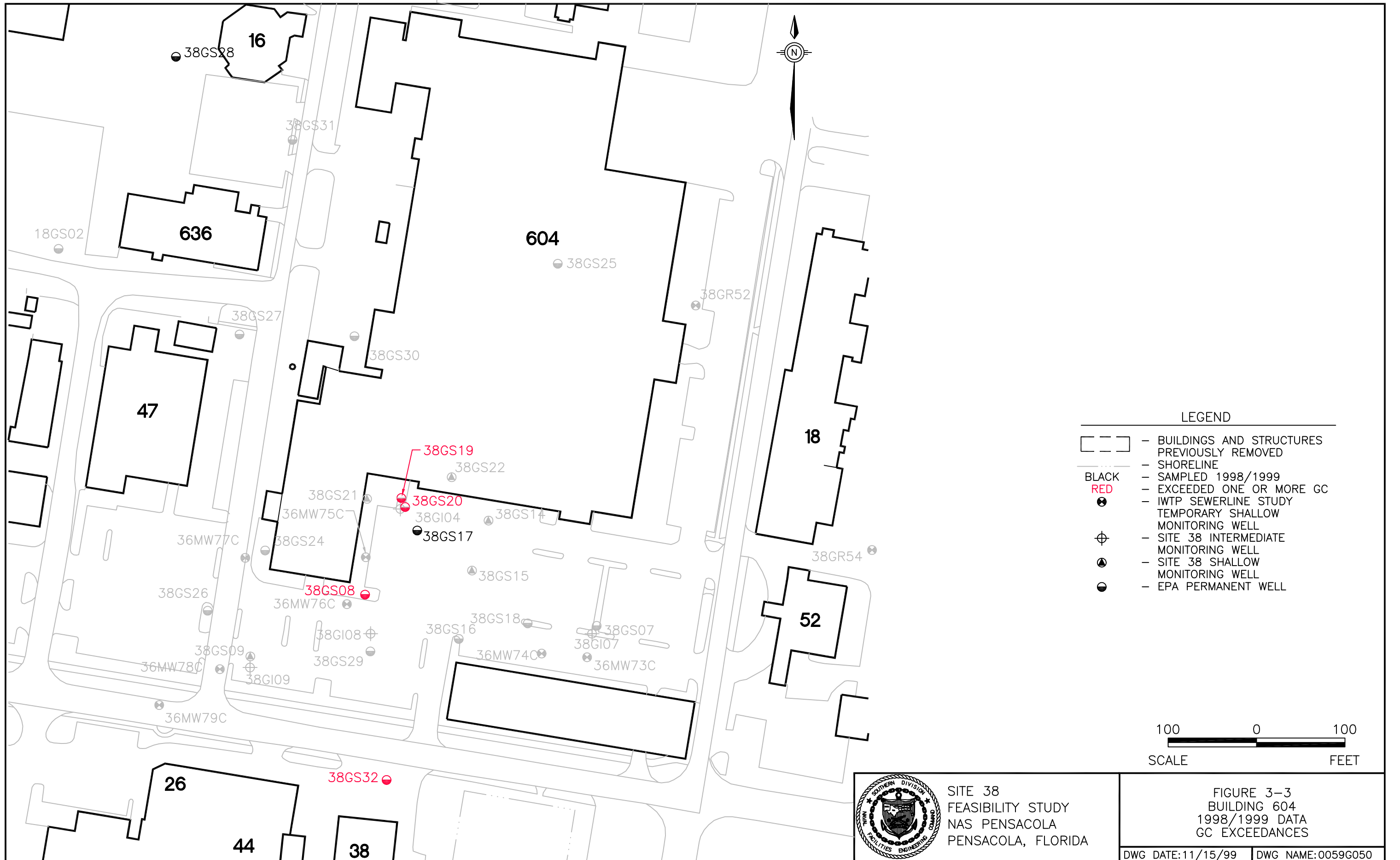


Table 3-1
 Building 604 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (μg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
Surficial Wells								
38GS07	Lead	15	18.6	ND			ND	38GS07
	Vinyl Chloride	1	ND	6.2			6.2	
38GS08	Antimony	6	ND		210		210.0	38GS08
	Cadmium	5	14.7		50.0		50.0	
	Chromium	100	233.0		NE		100.0	
	Lead	15	79.2		116.0		116.0	
	Tetrachloroethene	3	14.0		8.0		8.0	
	Trichloroethene	3	33.0		24.0		24.0	
	Vinyl Chloride	1	6.0		ND		ND	
38GS09	Lead	15	58.8	ND			ND	38GS09
	bis(2-Ethylhexyl)phthalate (BEHP)	6	ND	11.0			11.0	
	Trichloroethene	3	6.0	8.4			8.4	
	Vinyl Chloride	1	12.0	6.6			6.6	

Table 3-1
 Building 604 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS14	Cadmium	5	14.5				14.5	38GS14
	Lead	15	118.0				118.0	
	Tetrachloroethene	3	20.0				20.0	
	Trichloroethene	3	19.0				19.0	
38GS15	Lead	15	52.0				52.0	38GS15
	Naphthalene	20	140.0 J				140.0	
	1,1-Dichloroethene	7	180.0 J				180.0	
	Ethylbenzene	30	89.0					
	Vinyl Chloride	1	41.0 J				41.0	
38GS17	Lead	15	65.2	ND			ND	38GS17
	Naphthalene	20	NE	24			24	
	1,1 Dichloroethene	7	ND	21.0 J		ND	21.0	
	cis-1,2-Dichloroethene	70	ND	460.0		ND	ND	
	Tetrachloroethene	3	4.0 J	110.0		ND	ND	
	Trichloroethene	3	ND	19.0 J		ND	ND	
	Vinyl Chloride	1	1600.0 D	3700.0		ND	ND	

Table 3-1
Building 604 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS18	Lead	15	71.2 J	NE			ND	38GS18
	2,4-Dinitrotoluene	0.1	2.0 J	ND			ND	
	Tetrachloroethene	3	41.0	10.0			10.0	
	Trichloroethene	3	20.0	7.6			7.6	
38GS19	Antimony	6	ND		60.0		60.0	38GS19
	Cadmium	5	382.0		NE		NE	
	Chromium	100	544.0		NE		NE	
	Lead	15	180.0		58.0		58.0	
	1,2-Dichloroethene (total)	63	130.0 J		32.0		NE	
	1,1,2,2-Tetrachloroethane	0.2	ND		22.0		22.0	
	Tetrachloroethene	3	240.0		22.0		22.0	
	Trichloroethene	3	41.0		22.0		22.0	
	Vinyl Chloride	1	29.0		3.0		3.0	

Table 3-1
 Building 604 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results ($\mu\text{g/L}$)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS20	Cadmium	5	34.1				34.1	38GS20
	Chromium	100	378.0				378.0	
	Lead	15	110.0				110.0	
	1,2-Dichloroethene (total)	63	970.0 D			ND	ND	
	Tetrachloroethene	3	14.0 J			ND	ND	
	Vinyl Chloride	1	1100.0 D			15	15	
38GS21	Cadmium	5	336.0				336.0	38GS21
	Chromium	100	297.0				297.0	
	Lead	15	639.0				639.0	
	1,2-Dichloroethene (total)	63	100.0 J				100.0	
	Tetrachloroethene	3	280.0				280.0	
	Trichloroethene	3	13.0 J				13.0	
	Vinyl Chloride	1	15.0 J				15.0	
38GS22	Tetrachloroethene	3		7.0A			7.0	38GS22
	Trichloroethene	3		9.0A			9.0	
	Vinyl Chloride	1		70.0			70.0	
38GS24	Cadmium	5		11.0			11.0	38GS24
	Trichloroethene	3		3.6J			3.6	

Table 3-1
Building 604 General Criteria Exceedances

			Sample Results (µg/L)				Data Used for Defining	
Well ID	Parameter	GC	1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS29	Trichloroethene	3		4.0	AJ		4.0	38GS29
	Vinyl Chloride	1		43.0			43.0	
38GS32	Antimony	6		ND	190		190.0	38GS32
	Lead	15		ND	24.0		24.0	
	bis(2-Ethylhexyl) phthalate(BEHP)	6		22.0			22.0	
	cis-1,2-Dichloroethene	70		640.0	NE		NE	
	Trichloroethene	3		340.0	5.0		5.0	
	Tetrachloroethene	3		820.0	5.0		5.0	
	Vinyl Chloride	1		130.0	14.0		14.0	
Intermediate Wells								
38GI04	Cadmium	5	14.5	ND			ND	38GI04
	Chromium	100	370.0	ND			ND	
	Vinyl Chloride	1	ND	4.2			4.2	
38GI08	Vinyl Chloride	1	ND	1.9			ND	38GI08
IWTP Sewer Investigation Wells								
36GR73C	Lead	15	265.0				265.0	36GR73C
36GR74C	Lead	15	367.0				367.0	36GR74C

Table 3-1
 Building 604 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
36GR75C	Cadmium	5	8.1				8.1	36GR75C
	Lead	15	39.8				39.8	
	1,2-Dichloroethane	3	70				70	
	Tetrachloroethane	3	5.0	J			5.0	
	Trichloroethene	3	13.0				13.0	
	Vinyl Chloride	1	38.0				38.0	
36GR76C	Cadmium	5	45.9				45.9	36GR76C
	Chromium (total)	100	472.0				472.0	
	Lead	15	374.0				374.0	
36GR77C	Chromium	100	156.0				156.0	36GR77C
	Lead	15	47.2				47.2	
	Benzo(a)anthracene	0.2	8.0	J			8.0	
	Benzo(a)pyrene	0.2	7.0	J			7.0	
	Benzo(b)fluoranthene	0.2	6.0	J			6.0	
	Benzo(k)fluoranthene	0.5	6.0	J			6.0	
	Chrysene	4.8	7.0	J			7.0	

Table 3-1
Building 604 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
37GR78C	Lead	15	20.3				20.3	37GR78C
36GR79C	Lead	15	51.7				51.7	36GR79C

Notes:

- A = 1993/1994 sampling was performed using bailing, and inorganic data are considered to be biased high due to an elevated suspended solids content, as a result of sample collection methods. All data collected after 1994 were collected using quiescent sampling methods, which reduces the suspended solids content. In addition, sampling performed in 1998 and 1999 has shown significant concentration changes with regard to VOCs and lead; therefore, 1994 and 1995 data are considered to be conservatively high for most parameters.
- GC = General criteria (taken from FAC 62-777). See Appendix C for a complete screening of contaminants detected at Site 38 versus FDEP SCTLs.
- ND = Parameter not detected
- NE = Parameter did not exceed screening level
- (blank) = Parameter was not analyzed.

Antimony was detected in three wells, 38GS08, 38GS19, and 38GS32, during the 1998 sampling event, at concentrations of 210 $\mu\text{g/L}$, 60 $\mu\text{g/L}$, and 190 $\mu\text{g/L}$, respectively. As antimony was not quantified during previous events, it is unclear whether these detections are anomalous or representative of groundwater conditions. Because the data do not represent a wide-spread (lateral) area impacted by antimony, it will be regarded as a secondary parameter of concern, as it is collocated with TVOC contamination described above.

During the 1993 RI, lead concentrations within the plume area ranged from non-detect to 639 $\mu\text{g/L}$ (38GS21 [1994 data]). Lead was detected above GCs in 16 wells sampled during the RI, and then in 38GS32 sampled for the first time in 1995; in the six wells analyzed for lead during later events, lead concentrations have decreased in five of the six wells.

Cadmium concentrations in the plume area ranged up to 336 $\mu\text{g/L}$ (38GS21 [1994 data]) and chromium concentrations up to 378 $\mu\text{g/L}$ (38GS20 [1994 data]). Cadmium and chromium were not detected consistently in all wells: detections were limited to a small area adjacent to Building 604, and were not detected in wells more removed from the building, including wells downgradient.

Overall, inorganic concentrations decreased significantly in post-RI sampling events, most likely due to sampling technique. During the RI, wells were purged and sampled using bailer techniques, which typically generate highly turbid samples with significant suspended solids. Quiescent techniques were used during subsequent sampling events to assess the dissolved (or mobile) fraction within groundwater. As a result, concentrations decreased by one or more order of magnitude (e.g., 38GS19). Subsequent sampling data are expected to be more reliable than RI data for inorganic contaminants. Overall, lead concentrations have declined, possibly due to precipitation within the aquifer as lead sulfide. This phenomenon will be discussed in more detail during evaluation of Alternative G2: monitored natural attenuation (MNA).

Several isolated SVOCs were detected in groundwater and include: bis(2-ethylhexyl)phthalate (BEHP) (11 and 22 $\mu\text{g/L}$ in 38GS09 and 38GS32, respectively), naphthalene (140 $\mu\text{g/L}$ in 38GS15 and 24 $\mu\text{g/L}$ in 38GS17), and 2,4-dinitrotoluene (2 $\mu\text{g/L}$ in 38GS18). PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, and chrysene) were detected in one well, temporary IWTP sewer investigation well 36GR77C, but in none of the adjacent monitoring wells completed during later investigations. SVOC contamination is not consistent across the site, and no significant mass appears to be present in Site 38 wells.

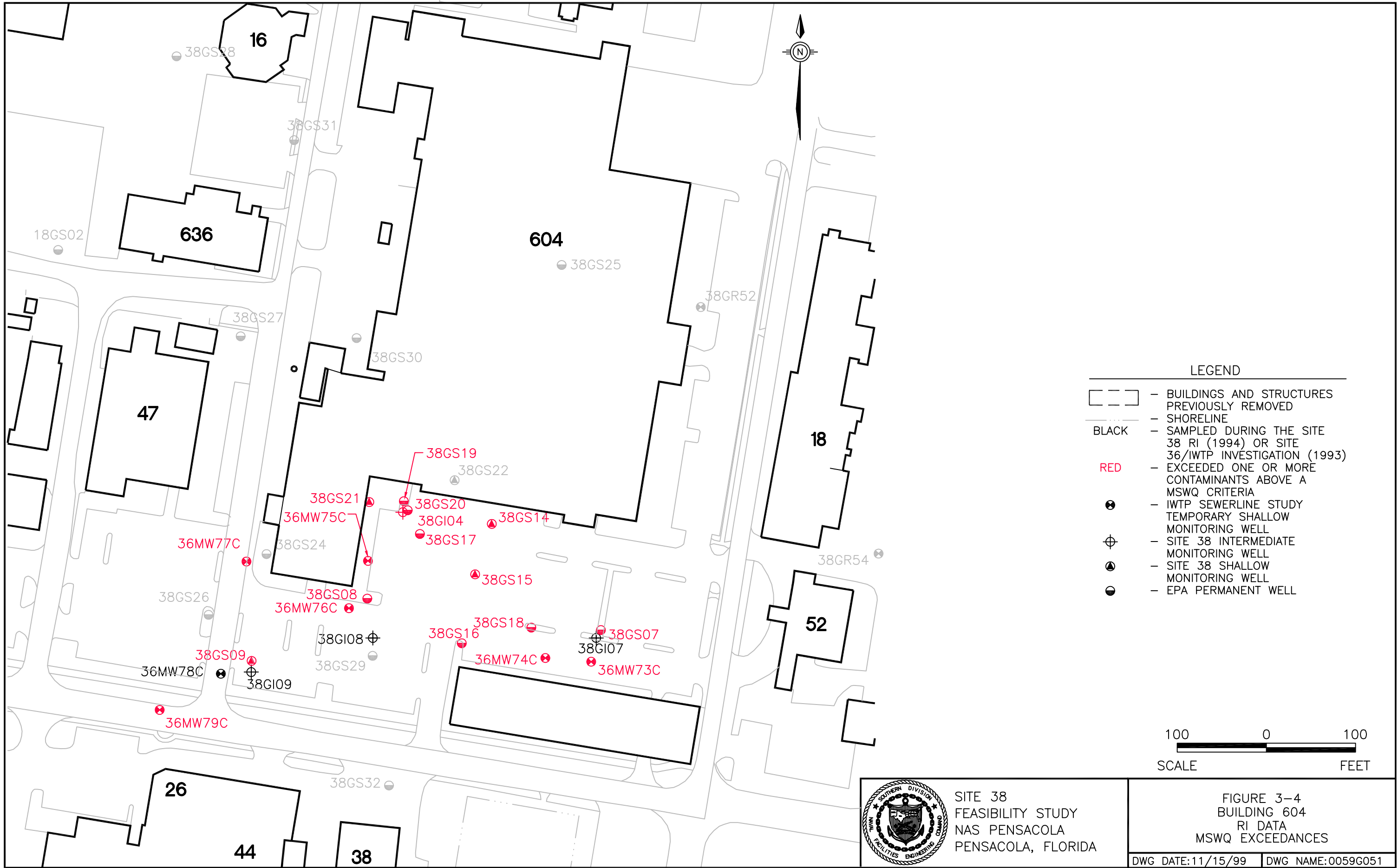
3.1.1.2 Comparison to Marine Surface Water Quality (MSWQ) Criteria

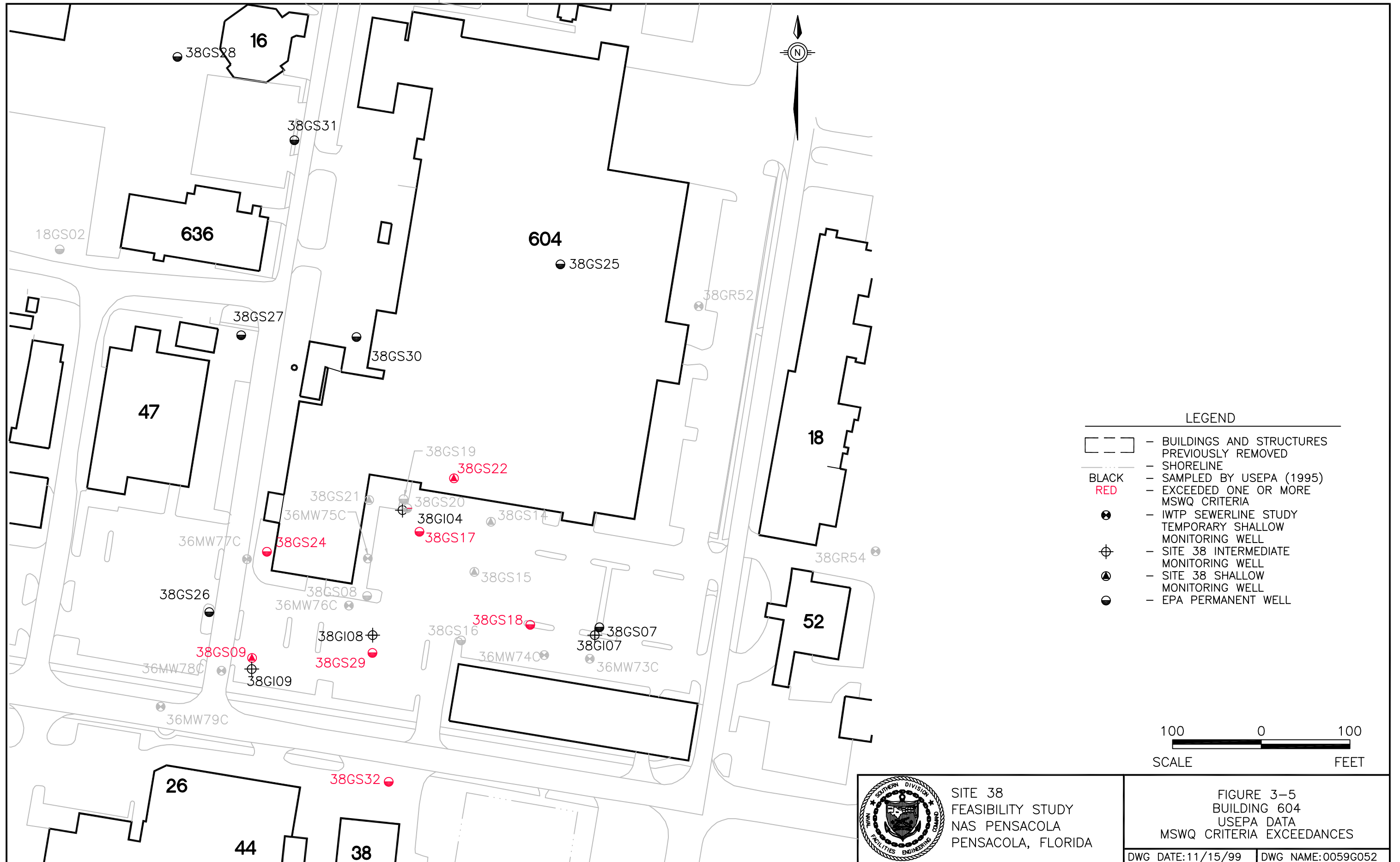
Building 604 groundwater data were compared to MSWQ criteria, because site groundwater may discharge to Pensacola Bay, a marine environment, above MSWQ limits. Table 3-2 presents the data by well and presents all parameters that exceeded an MSWQ limit. Groundwater exceedances are presented on Figures 3-4, 3-5, and 3-6 for RI data, EPA data, and 1998/1999 data, respectively.

Of contaminants detected above MSWQ criteria, chlorinated VOCs and lead were encountered consistently across the site (using 1994 data). Decreases in contaminant concentrations for both VOCs and lead have been documented during subsequent sampling events, indicating less risk to marine water bodies. No adverse effect has been observed in Pensacola Bay to date. No impacts are anticipated, due to the bay's assimilative capacity and the dilution/mixing which occurs at the groundwater-surface water interface.

Mercury, cadmium, nickel, cyanide, PAHs, and BEHP were all detected above MSWQ criteria in the Building 604 area. However, detections were isolated and did not indicate the presence of widespread groundwater contamination:

- Mercury concentrations exceeding MSWQ were encountered in wells 38GS07, 38GS08, and 38GS09 but not at wells between these locations. Mercury was also quantified above MSWQ in 38GS19, but not in surrounding wells. Three temporary IWTP sewer investigation wells also detected mercury above MSWQ, but the locations did not always correlate with data from later, permanent wells. Mercury was not quantified above MSWQ in wells downgradient, suggesting no continuous mercury plume in groundwater.
- Cadmium was quantified in nine wells, including 38GS08, 38GS14, 38GS19, 38GS20, 38GS21, 38GS24, 38GI04, 37GR75C, and 36GR78C. However, intervening well locations (38GS09, 38GS29, 38GS16, 38GS18) did not quantify cadmium above MSWQ. These data suggest that cadmium is not a widespread contaminant in groundwater and that source mass within the aquifer is negligible.
- Nickel was quantified at least once in five wells over the course of multiple investigations, including 38GS08 (30 $\mu\text{g/L}$ in 1998), 38GS20 (16 $\mu\text{g/L}$ in 1994), 38GS24 (12 $\mu\text{g/L}$ in 1995), 38GS28 (30 $\mu\text{g/L}$ in 1998), and 36GR77C (11.6 $\mu\text{g/L}$ in 1993). However, intervening well locations (38GS09, 38GS30, 36GR75C) did not quantify nickel above MSWQ. These data suggest that nickel is not a widespread contaminant in groundwater and that source mass within the aquifer is negligible.





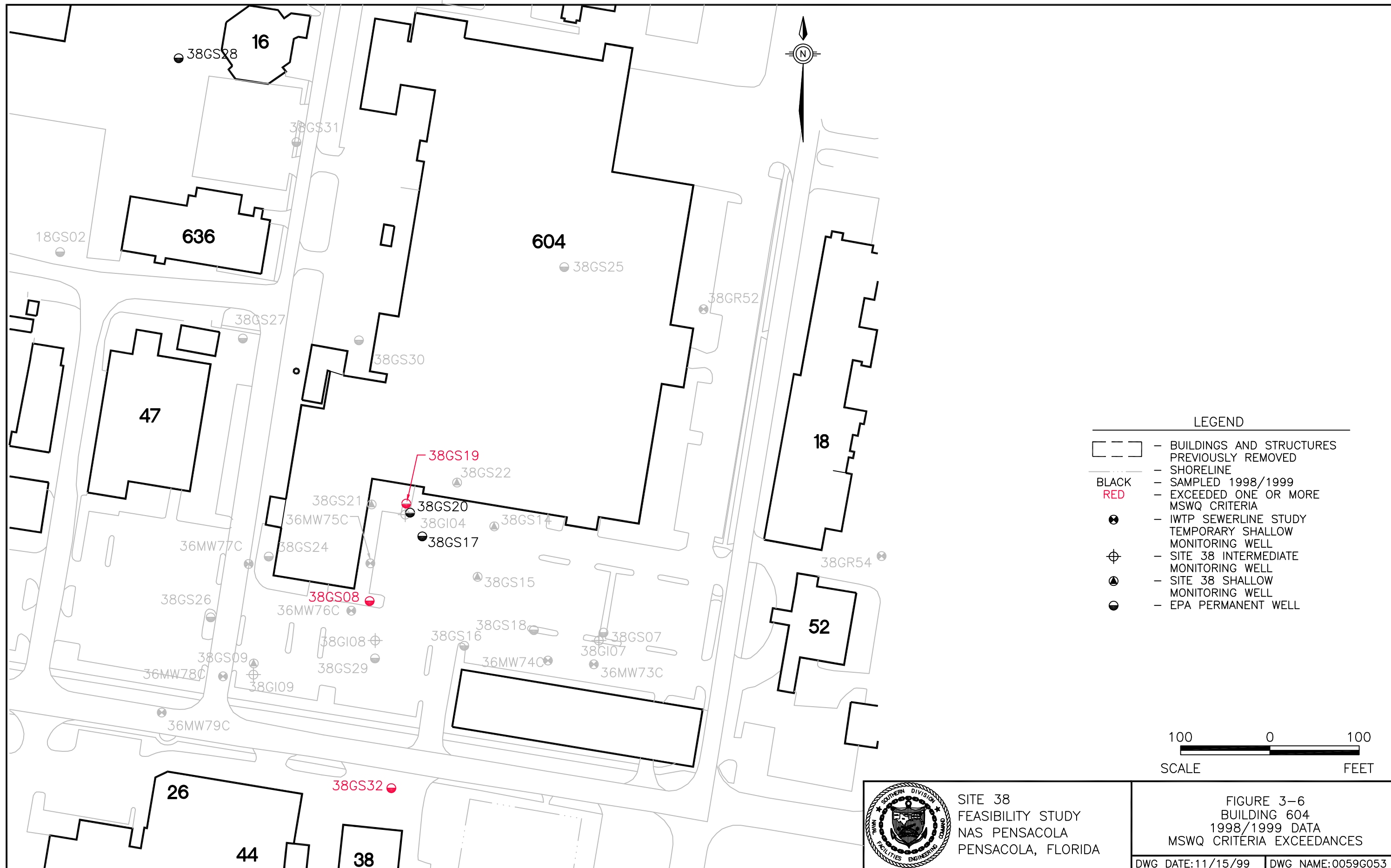


Table 3-2
Building 604 Marine Surface Water Quality Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
Surficial Wells								
38GS07	Lead	5.6	18.6		ND		ND	38GS07
	Mercury	0.012	1.0 J		ND		ND	
38GS08	Cadmium	9.3	14.7			50.0	50.0	38GS08
	Lead	5.6	79.2			116.0	116.0	
	Mercury	0.012	0.67			0.2	0.2	
	Nickel	8.3	ND			30.0	30.0	
	Tetrachloroethene	8.85	14.0			8.0	8.0	
38GS09	BEHP	0.02	ND		11.0		11.0	38GS09
	Lead	5.6	58.8		ND		ND	
	Mercury	0.012	0.31 J		ND		ND	
38GS14	Cadmium	9.3	14.5				14.5	38GS14
	Lead	5.6	118.0				118.0	
	1,1-Dichloroethene	3.2	5.0				20.0	
	Tetrachloroethene	8.85	20.0				19.0	
38GS15	Lead	5.6	52.0				52.0	38GS15
	Naphthalene	26	140.0 J				140.0	
38GS16	Lead	5.6	11.0 J				11.0	38GS16

Table 3-2
 Building 604 Marine Surface Water Quality Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS17	Lead		65.2	ND			ND	38GS17
	1,1-Dichloroethene		ND	21.0 J			21.0	
	Tetrachloroethene		NE	110.0		ND	ND	
38GS18	Lead	5.6	71.2 J	3.3			NE	38GS18
	Acenaphthene	3	4.0	NE			NE	
	Anthracene	0.3	17.0	ND			ND	
	Fluoranthene	0.3	23.0 J	7.0 J			7.0	
	Phenanthrene	0.031	170	ND			ND	
	Pyrene	0.3	11.0	8.8 J			8.8	
	1,1-Dichloroethene	3.2	4.0 J	NE			NE	
	Tetrachloroethene	8.85	41.0	10.0			10.0	
38GS19	Cadmium	9.3	382.0		NE		NE	38GS19
	Lead	5.6	180.0		58.0		58.0	
	Mercury	0.012	ND		0.3		0.3	
	Tetrachloroethene	8.85	240.0		22.0		22.0	

Table 3-2
Building 604 Marine Surface Water Quality Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS20	Cadmium	9.3	34.1				34.1	38GS20
	Lead	5.6	110.0				110.0	
	Nickel	0.012	16.0				16.0	
	Tetrachloroethene	8.85	14.0			ND	ND	
38GS21	Cadmium	9.3	336.0				336.0	38GS21
	Lead	5.6	639.0				639.0	
	Tetrachloroethene	8.85	280.0				280.0	
38GS24	Cadmium	9.3		11.0			11.0	38GS24
	Nickel	8.3		12.0			12.0	
38GS28	Nickel	8.3		ND	30.0		30.0	38GS28
38GS29	Cyanide	1.0		17.0			17.0	38GS29
38GS32	Lead	5.6		ND	24		24.0	38GS32
	bis(2-Ethylhexyl) phthalate(BEHP)	0.02		22.0			22.0	
	Tetrachloroethene	8.85		820.0	5.0		5.0	
	Trichloroethene	80.7		340.0	5.0		5.0	

Table 3-2
 Building 604 Marine Surface Water Quality Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994^	1995	1998	1999	Areas for FS	Well ID
Intermediate Wells								
38GI04	Cadmium	9.3	14.5	ND			ND	38GI04
	Lead	5.6	13.6	ND			ND	
IWTP Sewer Investigation Wells								
36GR73C	Cyanide	1.0	2.1	J			2.1	36GR73C
	Lead	5.6	265.0				265.0	
	Mercury	0.012	0.28				0.28	
36GR74C	Lead	5.6	367				367	36GR74C
	Mercury	0.012	0.28				0.28	
36GR75C	Cadmium	9.3	8.1				8.1	36GR75C
	Cyanide	1.0	9.9				9.9	
	Lead	5.6	39.8				39.8	
	1,2-Dichloroethane	5	70				70	
36GR76C	Cadmium	9.3	45.9				45.9	36GR76C
	Cyanide	1.0	18.8				18.8	
	Lead	5.6	374.0				374.0	
	Mercury	0.012	1.0				1.0	
	1,2-Dichloroethane	5	19.0				19.0	

Table 3-2
Building 604 Marine Surface Water Quality Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
36GR77C	Cyanide	1.0	11.9				11.9	36GR77C
	Lead	5.6	47.2				47.2	
	Nickel	8.3	11.6				11.6	
	Benzo(a)anthracene	0.031	8.0	J			8.0	
	Benzo(a)pyrene	0.031	7.0	J			7.0	
	Benzo(b)fluoranthene	0.031	6.0	J			6.0	
	Benzo(k)fluoranthene	0.031	6.0	J			6.0	
	Chrysene	0.031	7.0	J			7.0	
	Fluoranthene	0.3	19.0	J			19.0	
	Phenanthrene	0.031	10.0	J			10.0	
	Pyrene	0.3	15.0	J			15.0	
38GR78C	Lead	5.6	20.3				20.3	38GR78C
38GR79C	Lead	5.6	51.7				51.7	38GR79C

Notes:

- A = 1993/1994 sampling was performed using bailing, and inorganic data are considered to be biased high due to an elevated suspended solids content, as a result of sample collection methods. All data collected after 1994 were collected using quiescent sampling methods, which reduces the suspended solids content. In addition, sampling performed in 1998 and 1999 has shown significant concentration changes with regard to VOCs and lead; therefore, 1994 and 1995 data are considered to be conservatively high for most parameters.
- MSWQ = Marine surface water quality criteria (taken from FAC 62-777). See Appendix C for a complete screening of contaminants detected at Site 38 versus FDEP SCTLs.
- ND = Parameter not detected
- NE = Parameter did not exceed screening level
- blank = Parameter was not analyzed.

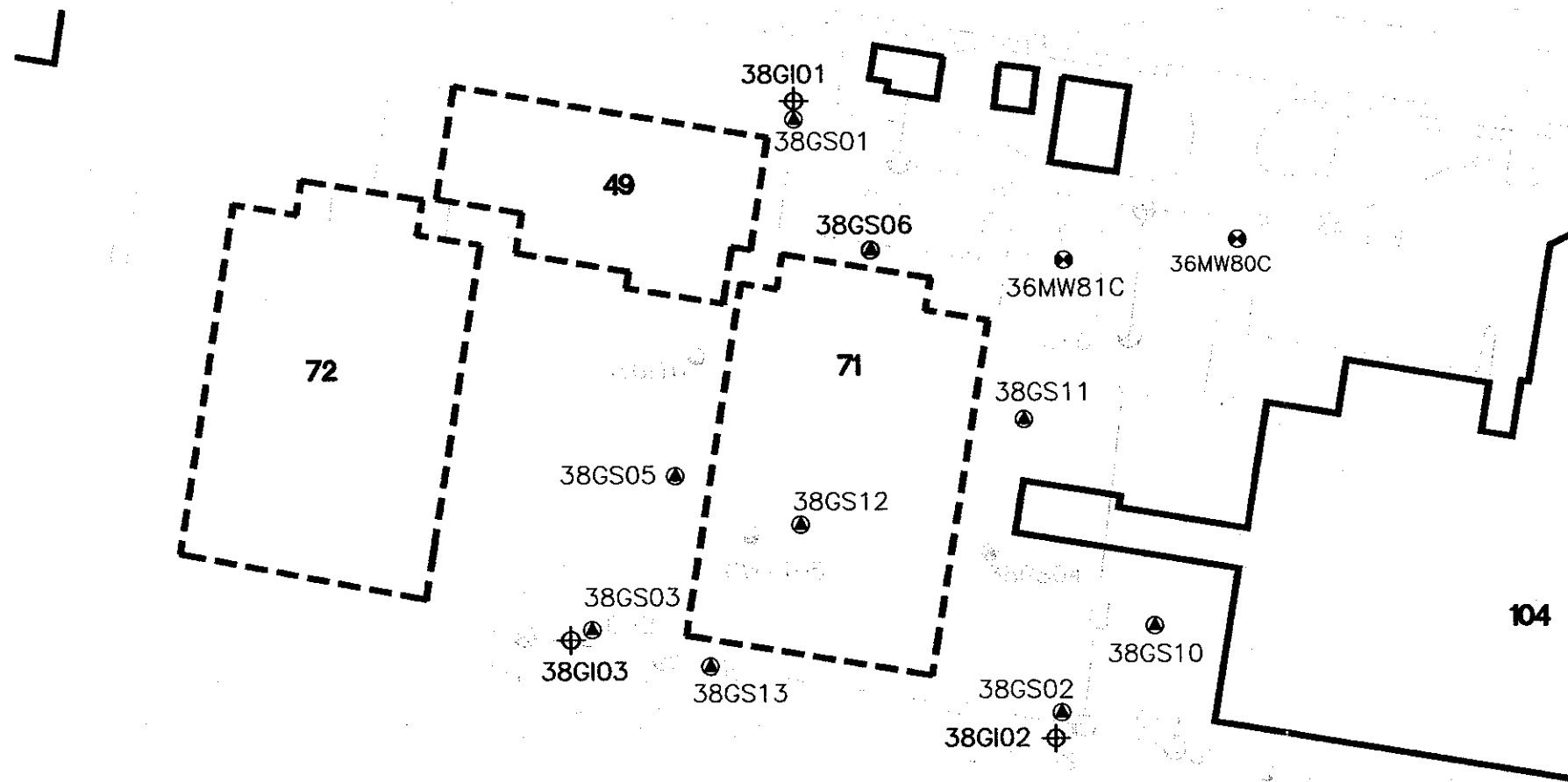
- Cyanide was only quantified in wells sampled during the 1993 IWTP sewer line investigation and 38GS29, sampled during the 1995 USEPA event. The irregular detections suggest cyanide is not a widespread aquifer problem.
- Various PAHs were encountered in 38GS15, 38GS18, and 37GR77C but not at any other adjacent or downgradient monitoring wells. These wells were completed below asphalt pavement, and data may be biased due to overlying asphaltic materials. However, groundwater data indicate that PAHs are not a widespread problem in groundwater and do not pose a threat to the adjacent marine water body.
- BEHP was quantified above MSWQ criteria in 38GS09 and 38GS32. Surrounding and downgradient wells did not quantify BEHP. It is unlikely that a significant source mass of BEHP is present within the aquifer, and therefore no threats to Pensacola Bay are anticipated.

3.1.2 Building 71

3.1.2.1 Comparison to General Criteria

Groundwater data from the Building 71 area were compared to GC, those wells having values exceeding a GC are presented in Table 3-3, and exceedances are presented on Figures 3-7, 3-8, and 3-9 for RI data, EPA data, and 1998/1999 data, respectively. VOCs, lead, chromium, cadmium, arsenic, antimony, and naphthalene were quantified in Building 71 groundwater above GCs.

VOC concentrations in the Building 71 area are limited in extent to 38GS12, located in the center of the former Building 71's foundation, and 38GS02, 38GS03, and 38GS13, which are slightly down-/side-gradient. TVOC concentrations in 38GS12 during the RI were over 1,400 $\mu\text{g/L}$. The other two wells exhibited concentrations only slightly exceeding GCs. RI data also indicated the



LEGEND

- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
- SHORELINE
- BLACK - SAMPLED DURING SITE 38 RI (1994)
- RED - LOCATION EXCEEDS ONE OR MORE GC
- - IWTP SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
- ⊕ - E/A&H SITE 38 INTERMEDIATE MONITORING WELL
- - E/A&H SITE 38 SHALLOW MONITORING WELL
- ⊕ - EPA WELL
- ⊕ - GRAVITY LINE (SEWER)
- ⊕ - FORCE MAIN (SEWER)
- ⊕ - MANHOLE

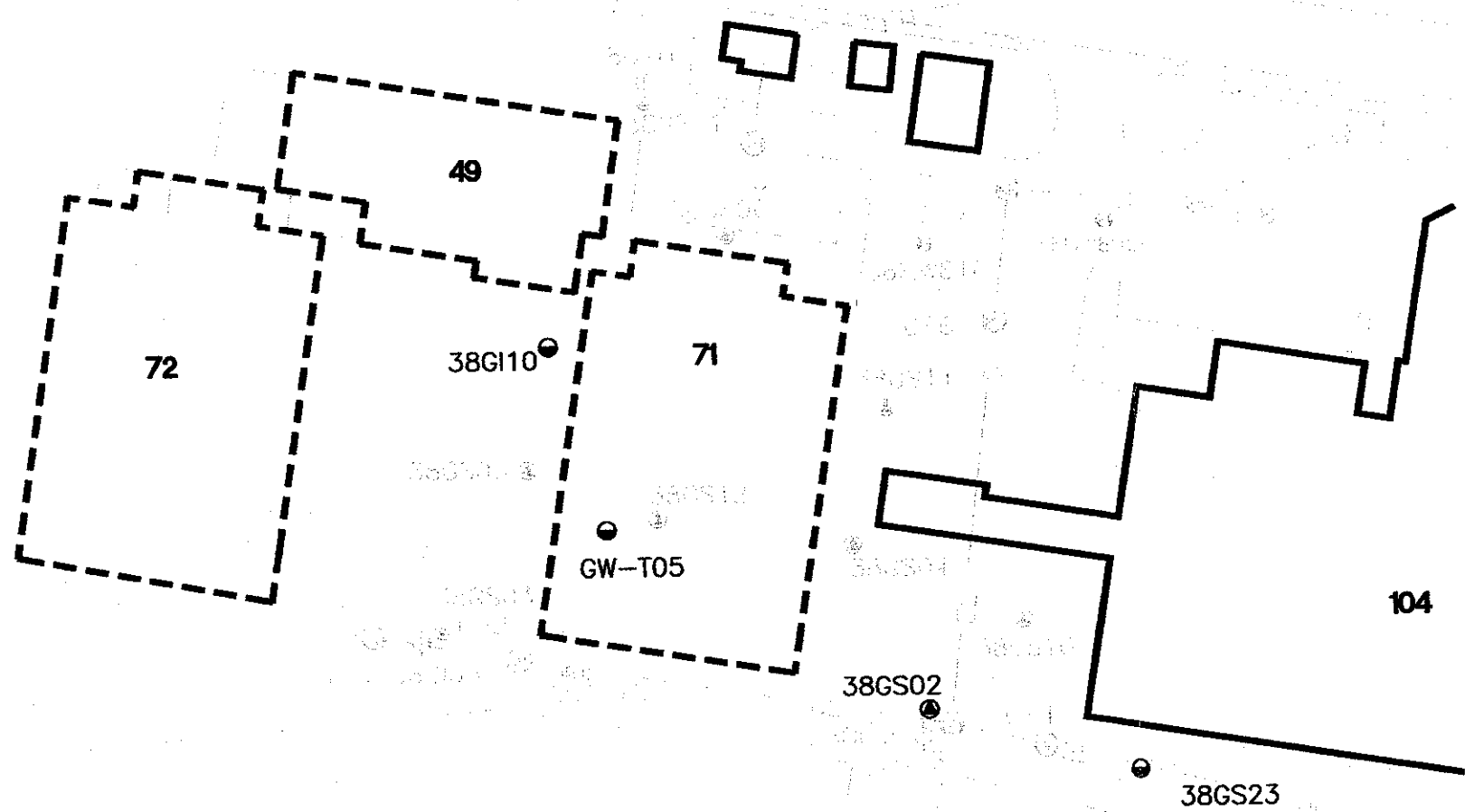
70 0 70
SCALE FEET



SITE 38
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

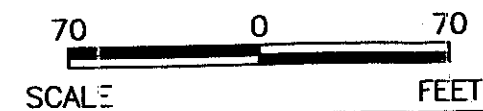
FIGURE 3-7
BUILDING 71 RI DATA
GC EXCEEDANCES

DWG DATE: 11/15/99 | DWG NAME: 0059G054



LEGEND

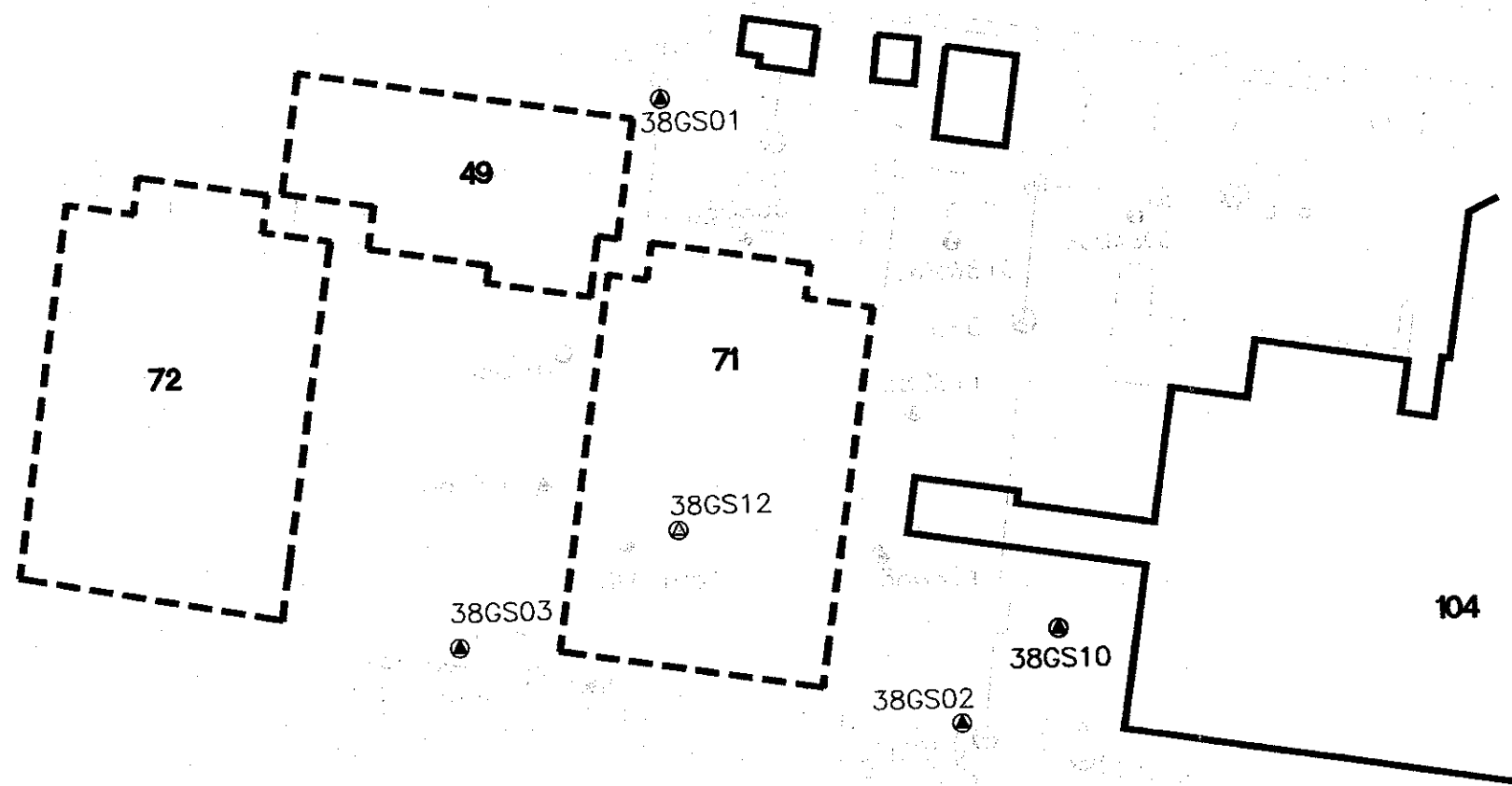
- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
- SHORELINE
- SAMPLED BY USEPA 1995
- LOCATION EXCEEDS ONE OR MORE GC
- IWTW SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
- E/A&H SITE 38 INTERMEDIATE MONITORING WELL
- E/A&H SITE 38 SHALLOW MONITORING WELL
- EPA WELL
- GRAVITY LINE (SEWER)
- FORCE MAIN (SEWER)
- MANHOLE



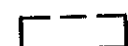
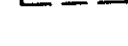


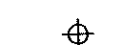







SITE 38
FEASIBILITY STUDY
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PENSACOLA, FLORIDA

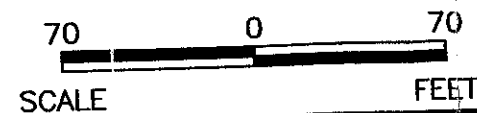
FIGURE 3-8
BUILDING 71 USEPA DATA
GC EXCEEDANCES

DWG DATE: 11/15/99 DWG NAME: 0059G055



LEGEND

-  - BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
-  - SHORELINE
-  - SAMPLED 1998/1999
-  - LOCATION EXCEEDS ONE OR MORE GC
-  - IWTP SEWERLINE STUDY TEMPORARY
-  - SHALLOW MONITORING WELL
-  - E/A&H SITE 38 INTERMEDIATE MONITORING WELL
-  - E/A&H SITE 38 SHALLOW MONITORING WELL
-  - EPA WELL
-  - GRAVITY LINE (SEWER)
-  - FORCE MAIN (SEWER)
-  - MANHOLE



SITE 38
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 3-9
BUILDING 71 1998/1999 DATA
GC EXCEEDANCES

DWG DATE: 11/15/99 | DWG NAME: 0059G056

Table 3-3
Building 71 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (μg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
Surficial Wells								
38GS01	Lead	15	276.0		117.0		117.0	38GS01
38GS02	Lead	15	362.0	J	ND		ND	38GS02
	Naphthalene	20	44.0				44.0	
	Chloroethane	12	ND			13	13	
	Vinyl Chloride	1	12.0			ND	ND	
38GS03	Antimony	6	ND		70.0		70.0	38GS03
	Lead	15	88.5		ND		ND	
	Benzene	1	ND		2.0		2.0	
	TCE	3	ND		4.0		4.0	
	Vinyl Chloride	1	ND		3.0		3.0	
38GS05	Cadmium	5	9.70				9.7	38GS05
	Lead	15	55.8				55.8	
38GS10	Antimony	6	25.0				25.0	38GS10
	Lead	15	54.0		ND		ND	
38GS11	Lead	15	20.1				20.1	38GS11
	Chloroform	5.7	6.0				6.0	

Table 3-3
 Building 71 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS12	Antimony	6	ND		180.0		180.0	38GS12
	Arsenic	50	102.0		ND		102.0	
	Cadmium	5	NE		50.0		50	
	Chromium	100	326.0		ND		ND	
	Lead	15	280.0		128.0		128.0	
	Naphthalene	20	44.0				44.0	
	1,1,1-Trichloroethane	200	770.0 J		ND		ND	
	1,1-Dichloroethane	70	640.0 J		ND		ND	
	1,1-Dichloroethene	7	42.0		ND		ND	
	1,2,4-Trimethylbenzene	10	ND		23.0		23.0	
	1,3,5-Trimethylbenzene	10	ND		12.0		12.0	
	1,1,2,2-Tetrachloroethane	1.3	ND		100.0		100.0	
	Chloroform	5.7	24.0		ND		ND	
	Tetrachloroethene	3	33.0 J		102.0		102.0	
	Trichloroethene	3	53.0		25.0		25.0	
	Vinyl Chloride	1	ND		15		15.0	

Table 3-3
Building 71 General Criteria Exceedances

Well ID	Parameter	GC	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS13	Cadmium	5	11.0				11.0	38GS13
	Chromium	100	184.0				184.0	
	Lead	15	158.0				158.0	
	Trichloroethene	3	4.0				4.0	
	Vinyl Chloride	1	11.0				11.0	
1993 IWTP Sewer Investigation Wells								
36GR80C	Lead	15	220.0				220.0	38MW80C
36GR81C	Lead	15	48.9				48.9	38MW81C

Notes:

- A = 1993/1994 sampling was performed using bailing, and inorganic data are considered to be biased high due to an elevated suspended solids content, as a result of sample collection methods. All data collected after 1994 were collected using quiescent sampling methods, which reduces the suspended solids content. In addition, sampling performed in 1998 and 1999 has shown significant concentration changes with regard to VOCs and lead; therefore, 1994 and 1995 data are considered to be conservatively high for most parameters.
- GC = General criteria (taken from FAC 62-777). See Appendix C for a complete screening of contaminants detected at Site 38 versus FDEP SCTLs.
- ND = Parameter not detected
- NE = Parameter did not exceed screening level
- blank = Parameter was not analyzed.

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chloroform in 38GS11 at a concentration slightly exceeding its GC. Data collected during the 1998 MNA evaluation suggested that natural attenuation processes are significant in the Building 71 area, with TVOC concentrations in 38GS12 decreasing to 127 $\mu\text{g/L}$. As discussed previously, MNA processes are expected to be ongoing within the aquifer and will be discussed further as alternative G2, Monitored Natural Attenuation.

During the RI, lead was quantified above its GC in ten wells in the Building 71 area. However, during subsequent sampling events, lead was detected above its GC in only two of 5 wells using quiescent or low-flow sampling techniques. Both detections, in 38GS01 and 38GS12, indicated a 50% decrease in concentration using the less-aggressive sampling method. As discussed previously, the decreases in lead concentrations may be due to one or both of the following reasons:

- The use of quiescent sampling methods during post-RI events, which better represent the dissolved fraction in the aquifer.
- The precipitation of lead within the aquifer matrix as lead sulfide, possibly in conjunction with sulfide production associated with MNA processes.

Arsenic was quantified in only one well, 38GS12, above its GC. Chromium was detected during the RI in only one well, 38GS13, above its GC, at 184 $\mu\text{g/L}$. Cadmium was quantified above its GC in two wells, 38GS05 (9.7 $\mu\text{g/L}$) and 38GS13 (11 $\mu\text{g/L}$ in 1994, 50 $\mu\text{g/L}$ in 1998). Antimony was detected above its GC during the RI in only one well, 38GS10, at 25 $\mu\text{g/L}$. Antimony was detected above its GC in three wells, 38GS03 (70 $\mu\text{g/L}$), 38GS10 (25 $\mu\text{g/L}$), and 38GS12 (180 $\mu\text{g/L}$); surrounding wells did not exhibit antimony contamination. The majority of these data were collected during the RI, and are expected to exhibit the high bias attributable to bailer sampling techniques. Concentrations are expected to be lower if sampling events are repeated with

low-flow methods. These data and inferences suggest that inorganics are not a primary concern at the Building 71 site.

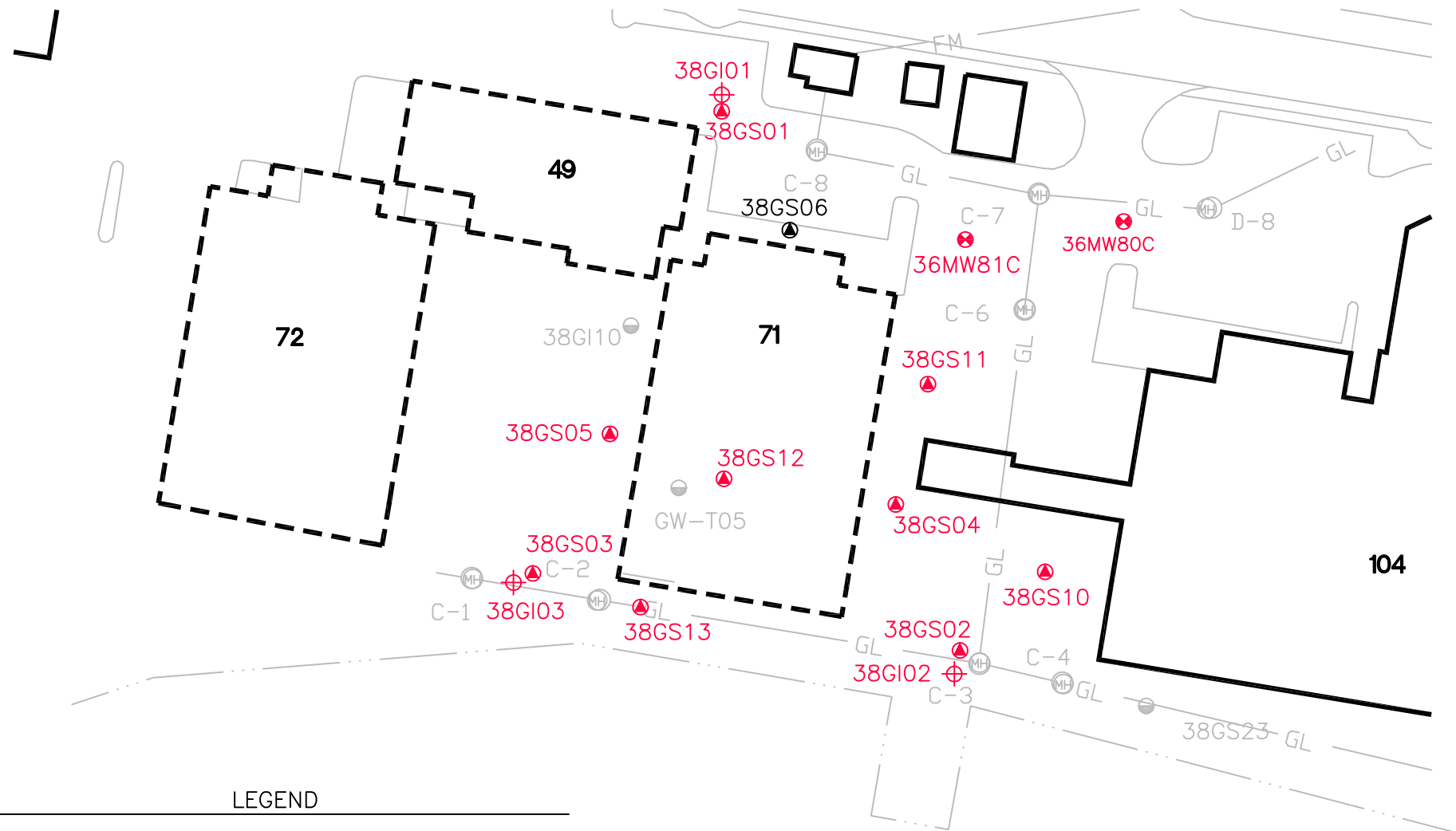
Napthalene was only quantified in 38GS02 and 38GS12. Napthalene was not detected in any wells adjacent to or downgradient of 38GS12 (e.g., GS-T05 and 38GS13) or adjacent to 38GS02 (38GS10 and 38GS23). These data suggest that naphthalene is not a continuous plume within the aquifer and therefore is not a threat to a theoretical future user.

1,2,4-Trimethylbenzene and 1,3,5-trimethylbenzene were detected in 1998 in well 38GS12; these compounds were not detected during previous events and may be anomalous.

3.1.2.2 Comparison to MSWQ Criteria

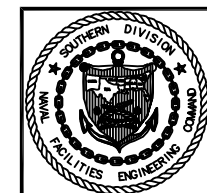
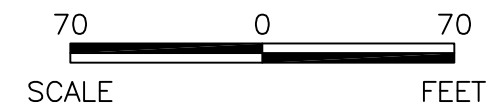
Groundwater data from Building 71 was compared to MSWQ criteria. Those wells having values exceeding MSWQ levels are presented in Table 3-4, and exceedances are presented on Figures 3-10, 3-11, and 3-12 for RI data, EPA data, and 1998/1999 data, respectively.

VOCs were detected during the RI in the Building 71 area in only one well exceeding MSWQ criteria, 38GS12. As discussed previously, 38GS12 exhibited the highest concentrations of VOCs; well T-05, adjacent to 38GS12, did not exhibit VOC contamination above any MSWQ criteria, indicating that the lateral extent of VOC contamination above surface water criteria is limited. As quantified during the resampling event in 1998, TVOC concentrations in 38GS12 have decreased by an order of magnitude. No adverse effect due to VOC contamination has been observed in Pensacola Bay to date. No impacts are anticipated, due to the bay's assimilative capacity and the dilution/mixing which occurs at the groundwater-saline surface water interface.



LEGEND

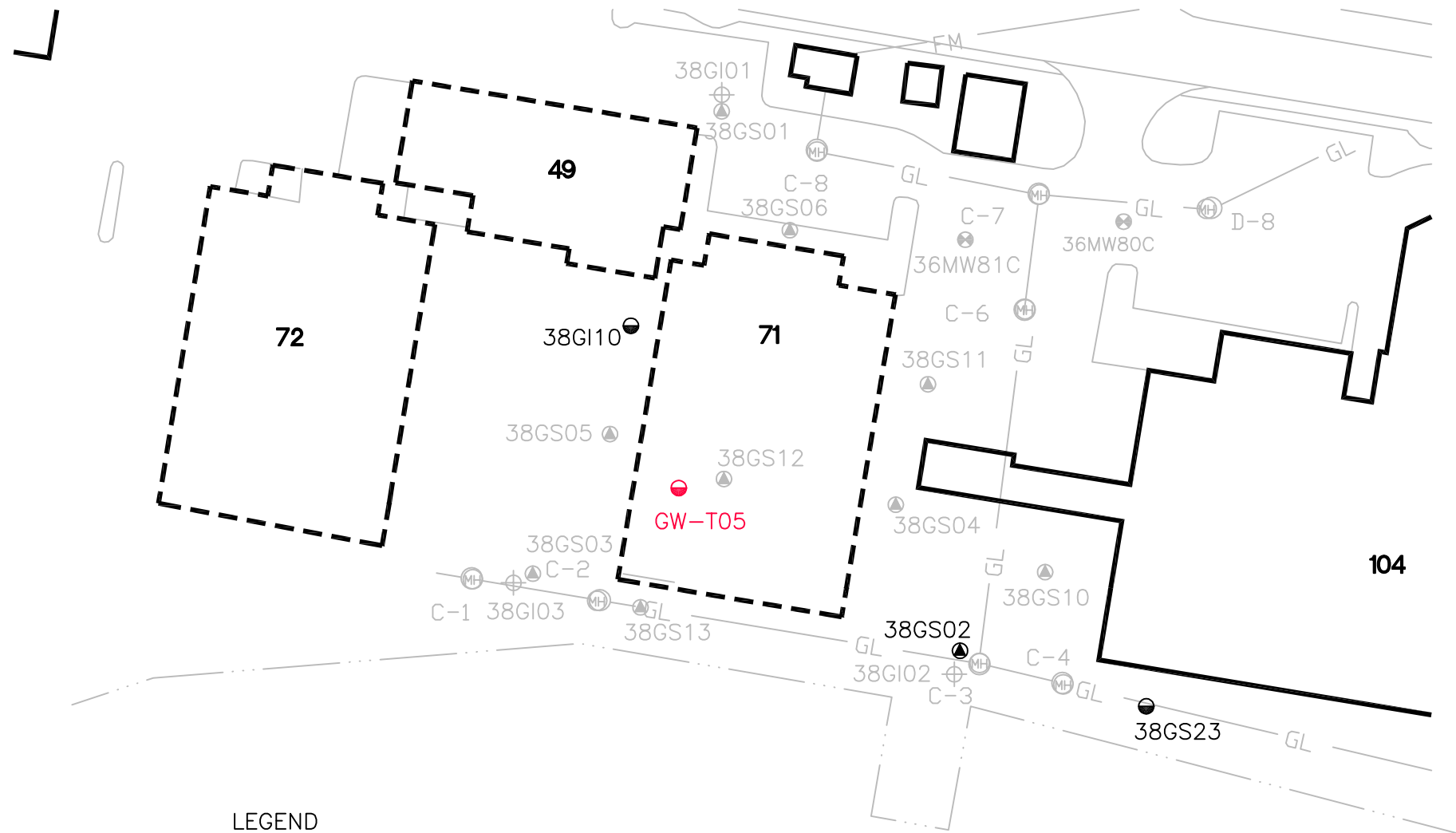
- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
- SHORELINE
- BLACK - SAMPLED DURING SITE 38 RI (1994)
- RED - LOCATION EXCEEDS ONE OR MORE MSWQ CRITERIA
- IWTP SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
- E/A&H SITE 38 INTERMEDIATE MONITORING WELL
- E/A&H SITE 38 SHALLOW MONITORING WELL
- EPA WELL
- GL - GRAVITY LINE (SEWER)
- FM - FORCE MAIN (SEWER)
- MH - MANHOLE



SITE 38
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

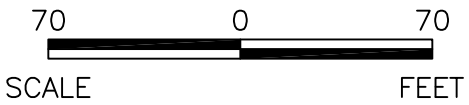
FIGURE 3-10
BUILDING 71 RI DATA
MSWQ CRITERIA EXCEEDANCES

DWG DATE: 11/15/99 | DWG NAME: 0059G057



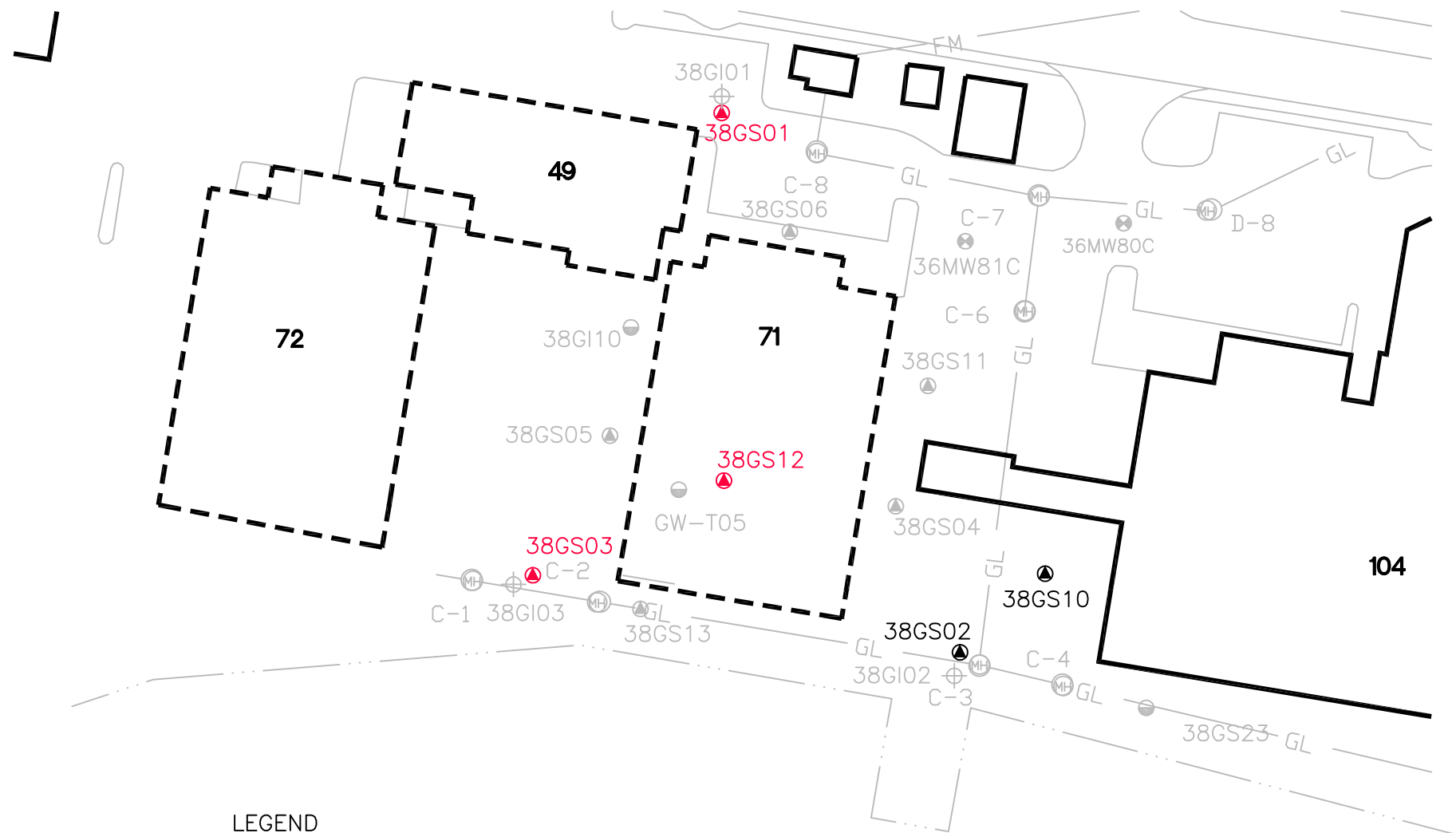
LEGEND

- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
- SHORELINE
- BLACK - SAMPLED BY USEPA (1995)
- RED - LOCATION EXCEEDS ONE OR MORE MSWQ CRITERIA
- IWTP SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
- E/A&H SITE 38 INTERMEDIATE MONITORING WELL
- E/A&H SITE 38 SHALLOW MONITORING WELL
- EPA WELL
- GRAVITY LINE (SEWER)
- FORCE MAIN (SEWER)
- MANHOLE



SITE 38
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

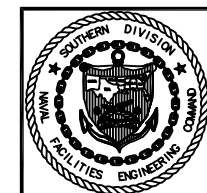
FIGURE 3-11
BUILDING 71 USEPA DATA
MSWQ CRITERIA EXCEEDANCES



LEGEND

- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
- SHORELINE
- BLACK - SAMPLED 1998/1999
- RED - LOCATION EXCEEDS ONE OR MORE MSWQ CRITERIA
- IWTP SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
- E/A&H SITE 38 INTERMEDIATE MONITORING WELL
- E/A&H SITE 38 SHALLOW MONITORING WELL
- EPA WELL
- GRAVITY LINE (SEWER)
- FORCE MAIN (SEWER)
- MANHOLE

70 0 70
SCALE FEET



SITE 38
FEASIBILITY STUDY
NAS PENSACOLA
PENSACOLA, FLORIDA

FIGURE 3-12
BUILDING 71 1998/1999 DATA
MSWQ CRITERIA EXCEEDANCES

DWG DATE: 11/15/99 | DWG NAME: 0059G059

Table 3-4
Building 71 Marine Surface Water Criteria Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
Surficial Wells								
38GS01	Lead	5.6	276.0		117.0		117.0	38GS01
	Nickel	8.3	ND		20.0		20.0	
38GS02	Lead	5.6	362.0 J		ND		ND	38GS02
	Naphthalene	26	44.0				44.0	
38GS03	Lead	5.6	88.5		ND		ND	38GS03
	Nickel	8.3	ND		20.0		20.0	
38GS04	Lead	5.6	14.0				14.0	38GS04
38GS05	Cadmium	9.3	9.7				9.7	38GS05
	Lead	5.6	55.8				55.8	
	Nickel	8.3	15.9				15.9	
38GS10	Beryllium	0.13	1.0				1.0	38GS10
	Lead	5.6	54.0		ND		ND	
	Mercury	0.012	0.33				0.33	
	Nickel	8.3	10.0				10.0	
38GS11	Lead	5.6	20.1				20.1	38GS11

Table 3-4
 Building 71 Marine Surface Water Criteria Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GS12	Arsenic	50	102.0		NE		NE	38GS12
	Cadmium	9.3	NE		50.0		50	
	Lead	5.6	280.0		128.0		128.0	
	Nickel	8.3	ND		30.0		30.0	
	Naphthalene	26	44.0				44.0	
	1,1,1-Trichloroethane	270	770.0 J		ND		ND	
	1,1-Dichloroethene	3.2	42.0		ND		ND	
	Tetrachloroethene	8.85	33.0 J		102.0		102.0	
38GS13	Cadmium	9.3	11.0				11.0	38GS13
	Lead	5.6	158.0				158.0	
38GST05	Phenanthrene	0.031		3.7 J			3.7	38GST05
1993 IWTP Sewer Investigation Wells								
36MW80C	Lead	5.6	220.0				220.0	38MW80C
36MW81C	Lead	5.6	48.9				48.9	38MW81C
Intermediate Wells								
38GI01	BEHP	0.02	3.0 J				3.0	38GI01
38GI02	Phenol	6.5	9.0 J				9.0	38GI02
	BEHP	0.02	1.0 J				1.0	

Table 3-4
Building 71 Marine Surface Water Criteria Exceedances

Well ID	Parameter	MSWQ Criteria	Sample Results (µg/L)				Data Used for Defining	
			1994 ^A	1995	1998	1999	Areas for FS	Well ID
38GI03	Beryllium	0.13	1.2 J				1.2	38GI03
	BEHP	0.02	1.0 J				1.0	

Notes:

- A = 1993/1994 sampling was performed using bailing, and inorganic data are considered to be biased high due to an elevated suspended solids content, as a result of sample collection methods. All data collected after 1994 were collected using quiescent sampling methods, which reduces the suspended solids content. In addition, sampling performed in 1998 and 1999 has shown significant concentration changes with regard to VOCs and lead; therefore, 1994 and 1995 data are considered to be conservatively high for most parameters.
- GC = General criteria (taken from FAC 62-777). See Appendix C for a complete screening of contaminants detected at Site 38 versus FDEP SCTLs
- ND = Parameter not detected
- NE = Parameter did not exceed screening level
- blank = Parameter was not analyzed.

The SVOCs naphthalene, phenol, BEHP, and phenanthrene were detected above MSWQ criteria in the Building 71 area. Naphthalene was detected in two wells, 38GS02 and 38GS12, both at a concentration of 44 $\mu\text{g/L}$; as discussed previously, these wells are not adjacent to one another and surrounding wells did not quantify naphthalene at concentrations which endanger marine surface water quality. Phenol was detected in one intermediate-depth well, 38GI02, at 9.0 $\mu\text{g/L}$; this phenol detection does not appear to delineate a large groundwater plume which may threaten the adjacent bay. BEHP was detected in all three of the site's intermediate wells, 38GI01, 38GI02, and 38GI03, at concentrations ranging from 1.0 $\mu\text{g/L}$ to 3.0 $\mu\text{g/L}$. Once again, the mass of BEHP present within the aquifer is small, and not expected to be a threat to Pensacola bay given the bay's assimilative capacity and the dilution/mixing which occurs at the groundwater-saline surface water interface. Phenanthrene was detected in one well, T-05, at 3.7 $\mu\text{g/L}$; phenanthrene was not detected at any adjacent or downgradient well and is not expected to threaten marine surface water quality.

The inorganics arsenic, beryllium, cadmium, lead, mercury, and nickel were detected above MSWQ criteria. Arsenic was detected in well 38GS12 at 6 $\mu\text{g/L}$; the quantification of this contaminant in only one well (and no adjacent or downgradient wells) suggests that it poses little or no threat to the adjacent Pensacola Bay. Beryllium was detected in shallow well 38GS10 (1.0 $\mu\text{g/L}$) and intermediate-depth well 38GI03 (1.2 $\mu\text{g/L}$); it was not detected at intervening well locations. Cadmium was detected in two wells, 38GS12 and 38GS13, at maximum concentrations of 50 $\mu\text{g/L}$ and 11.0 $\mu\text{g/L}$, respectively. Lead was detected in eleven wells during the RI at concentrations exceeding the MSWQ, but during the 1998 resampling event, it was detected in only two wells, 38GS01 and 38GS12, at concentrations of 117 $\mu\text{g/L}$ and 128 $\mu\text{g/L}$ respectively. Mercury was detected in well 38GS10 at a concentration of 0.33 $\mu\text{g/L}$. Nickel was quantified above its MSWQ in five wells, 38GS01, 38GS03, 38GS05, 38GS10, and 38GS12; nickel was not quantified in downgradient wells at concentrations which might pose a threat to the adjacent

marine surface water body. Overall, inorganic contaminants were discontinuous across the Building 71 site and likely do not pose a significant threat to the adjacent Pensacola Bay.

3.2 Remedial Goals

Florida regulations identify all groundwater in the state as potential drinking water and applies maximum contaminant levels (MCLs) as groundwater standards (FAC 62-550). Therefore, despite the demonstrated overall poor aquifer quality (high iron, aluminum, sodium, etc.), Florida regulations require MCLs to be appropriate remedial goals for Buildings 71 and 604, assuming its future use as a potable water source.¹

Table 3-5 lists groundwater remedial goals (RGs) for Site 38 for every compound detected above an RC; where MCLs were not available, RGs were obtained from FAC 62-777, a TBC regulation due to its applicability to other, similar sites (such as Brownsfield and dry cleaner/chlorinated solvent sites).

Table 3-5
Contaminant-Specific Remediation Goals for Groundwater at Site 38

Contaminant	RG (µg/L)
Antimony	6
Arsenic	50
Cadmium	5
Chromium	100
Lead	15
Benzo(a)anthracene	0.2
Benzo(a)pyrene	0.2
Benzo(b)fluoranthene	0.2

¹It should be noted that FDEP's application of MCLs to the surficial aquifer unit is despite the Navy's willingness to restrict groundwater use in the Site 38 area, thus preventing future consumptive exposure.

Table 3-5
Contaminant-Specific Remediation Goals for Groundwater at Site 38

Contaminant	RG ($\mu\text{g/L}$)
Benzo(k)fluoranthene	0.5
bis-(2-ethylhexyl)phthalate	6
Chrysene	4.8
2,4-Dinitrotoluene	14
Naphthalene	20
1,2,4-Trimethylbenzene	10
1,3,5-Trimethylbenzene	10
Benzene	1
Chloroethane	12
Chloroform	5.7
Ethylbenzene	30
1,1-Dichloroethane	70
1,2-Dichloroethane	3
1,1-Dichloroethene	7
1,2-Dichloroethene (total)	63
cis-1,2-Dichloroethene	70
1,1,2,2-Tetrachloroethane	1.3
Tetrachloroethylene (PCE)	3
1,1,1-Trichloroethane (TCA)	200
Trichloroethylene (TCE)	3
Vinyl Chloride	1

Note:

$\mu\text{g/L}$ = micrograms per Liter.

Although the aquifer is considered a potential source of drinking water, its actual use is considered unlikely for several reasons. As previously discussed, background concentrations of several parameters (including sodium, iron, and others) exceed primary and secondary drinking water standards, and is generally considered undesirable as drinking water. Potable water for the

NAS Pensacola area is derived from Corry Station. Land use in the Site 38 area is industrial, so it is unlikely that current or projected future users would access the surficial aquifer for domestic use. If water was not obtained from Corry Station in a future use scenario, it is likely that deeper, freshwater bearing units would be tapped for domestic use given the poor quality of upper water bearing units (e.g., the surficial aquifer's high sodium, aluminum, and iron).

Moreover, impacted groundwater at Site 38 is within 250 feet of Pensacola Bay at Building 71, and within 500 feet of Pensacola Bay at Building 604. It is highly possible that domestic use wells completed into the surficial aquifer into the Site 38 groundwater exceedance plumes would either intercept the groundwater-saline surface water interface, or induce saline intrusion, eliminating the option of potable use.

Remedial strategies for Site 38 will acknowledge the fact that current and projected land use in the area of impacted groundwater is industrial and likely to remain so. Moreover, the likelihood of the surficial aquifer's use, in light of higher quality, readily accessible potable sources, is low. Contamination in this aquifer, therefore, is considered a low-risk to human health.

RGs for Protection of Marine Surface Water Quality

Comparison of groundwater data with MSWQ criteria indicated several contaminants which exceeded MSWQ. Marine surface water criteria for all contaminants exceeding criteria are shown in Table 3-6; because most of these criteria are similar to MCLs or other GCs outlined in FAC 62-777, standards outlined in Table 3-5 should be protective of marine surface water.²

²While most contaminants have higher MSWQ criteria, notable exceptions are the PAHs, which are typically regarded as relatively immobile compounds which preferentially sorb to soil; these compounds were detected at very few wells at Site 38 and are considered a minimal threat to Pensacola Bay. Lead also has a lower MSWQ, but its human health standard of 15 $\mu\text{g/L}$ is a treatment-based limitation and achieving lower concentrations through treatment is typically regarded as impracticable. BEHP's MSWQ criteria is over 2 orders of magnitude lower than its human health criteria, but at Site 38 it was not detected consistently in groundwater and is not considered a significant threat to Pensacola Bay.

Moreover, MSWQ exceedances are collocated with RG exceedances, and therefore will be addressed by each alternative for impacted groundwater discussed in this FS.

Many of the compounds detected above MSWQ criteria at Site 38, including phenol, BEHP, naphthalene, and other semivolatile compounds were detected in only one or two well locations, and did not indicate the presence of a persistent, site-wide plume that would threaten adjacent surface water bodies. The primary contaminants at Site 38 (e.g., those encountered consistently across the site) include chlorinated VOCs and lead. Most importantly, these contaminants have never been quantified in surface water in Pensacola Bay adjacent to Site 38, indicating that fate and transport mechanisms through the groundwater/saline surface water discharge are adequate to protect the environment. Therefore, remedial actions specific to MSWQ criteria are already addressed through compliance with MCLs and other GCs. RGs for Site 38 are defined in Table 3-5.

Table 3-6
Comparison of GCs and MSWQ Criteria for Groundwater at Site 38

Contaminant	GC ($\mu\text{g/L}$)	MSWQ Criteria ($\mu\text{g/L}$)
Arsenic	50	50
Beryllium	did not exceed GC	
Cadmium	5	9.3
Cyanide	did not exceed GC	
Lead	15	5.6
Mercury	did not exceed GC	0.012
Nickel	did not exceed GC	8.3
Acenaphthene	did not exceed GC	3
Anthracene	did not exceed GC	0.3
Benzo(a)anthracene	0.2	0.031
Benzo(a)pyrene	0.2	0.031
Benzo(b)fluoranthene	0.2	0.031

Table 3-6
Comparison of GCs and MSWQ Criteria for Groundwater at Site 38

Contaminant	GC ($\mu\text{g/L}$)	MSWQ Criteria ($\mu\text{g/L}$)
Benzo(k)fluoranthene	0.5	0.031
bis-(2-ethylhexyl)phthalate	6	0.02
Chrysene	4.8	0.031
Fluoranthene	did not exceed GC	0.3
Naphthalene	20	26
Phenanthrene	did not exceed GC	0.031
Phenol	did not exceed GC	6.5
Pyrene	did not exceed GC	0.3
1,2-Dichloroethane	3	5
1,1-Dichloroethene	7	3.2
Tetrachloroethylene (PCE)	3	8.85
1,1,1-Trichloroethane (TCA)	200	270
Trichloroethylene (TCE)	3	80.7

Note:
 $\mu\text{g/L}$ = micrograms per Liter.

3.2.1 Building 604 Remedial Volumes

Groundwater in the Building 604 study area generally flows south-southeast towards the boat slip, where it discharges to Pensacola Bay. This area has been impacted by contamination from past activities and a plume can be defined by contaminant exceedances. To evaluate the effectiveness of each alternative, the volume of groundwater impacted by contaminants above RGs is presented in Table 3-7. Though the bulk of contamination is limited to the shallow portion of the aquifer (i.e., the top 20 feet of the surficial unit), worst-case volumes have been calculated assuming an aquifer thickness of approximately 35 feet (i.e., contamination is present in all portions of the surficial aquifer), and the porous media has a porosity of 30%.

3.2.2 Building 71 Remedial Volumes

Groundwater in the Building 71 area generally flows south into Pensacola Bay. This area has been impacted by contamination from past activities and a plume can be defined by contaminant exceedances. The volume of groundwater impacted above RGs is presented in Table 3-7.

Table 3-7
Groundwater Remedial Volumes

	Contaminants	Impacted Area	Impacted Volume	
		Square Feet	CY of Aquifer	Gallons of Water
Building 604	VOCs, SVOCs, Inorganics	130,800	170,000	10.3 million
Building 71	VOCs, SVOCs, Inorganics	34,000	31,500	1.9 million

Notes:

CY = Cubic yards of aquifer

VOCs = Volatile organic compounds

SVOCs = Semivolatile Organic Compounds

3.3 Identification and Screening of Technologies

This section describes the initial steps toward remedy selection: identification and screening of applicable technologies. After technologies are identified, they are reviewed for effectiveness, implementability, and cost. These criteria are discussed in Section 2.2.6. Based on this screening, technologies are either eliminated or retained for further consideration. Alternatives for remedial action at Site 38 were developed from the technologies retained.

Each treatment technology's objective, implementability, effectiveness, and cost are discussed in Table 3-8. They are consistent with technology-screening techniques presented in the NCP and USEPA guidance because they include containment, removal, disposal, and treatment options.

Table 3-8
 Technology Screening for Site 38 Groundwater

Technology	Description	Implementability	Effectiveness	Cost
In situ Groundwater Treatment				
Air Sparging • natural gas injection • biosparging	Air is injected into the aquifer to strip contaminants from the water via volatilization. Air sparging is usually operated in conjunction with a soil vapor extraction (SVE) system to capture the gases stripped from the water. Gases must be treated prior to release. Adding natural gas to the air stream may stimulate naturally occurring microbes to degrade and remove chlorinated solvents in groundwater. Similarly, air injected at a lower flow rate can be used to enhance biological activity.	Air sparging is implementable at Site 38. The paved areas of the site would help contain any gases produced. The water table should be deeper than 5 feet below ground surface. An air sparging system at Site 38 could not be integrated with an SVE system due to the shallow water table; this could increase the possibility of vapor-phase contaminants migrating to nearby buildings. A conservative estimate of VOC emissions is approximately 3.0 pounds per day. The effect of decreased permeability and possible redirection of groundwater flow would need significant evaluation during remedial design.	Air Sparging is effective at removing VOCs and fuel hydrocarbons from the groundwater. SVOC effectiveness varies with the specific compound. Air sparging does not effectively treat inorganics. An oxidized aquifer may result in precipitation or increased solubility of certain inorganic species (e.g., cadmium, which is more mobile under aerobic conditions). Increased oxidation would hinder the biodegradation of PCE and TCE.	Costs for air sparging vary with the specific methodology or modification employed at the site and whether extracted air requires additional treatment. An air sparging system can cost 40% less than traditional pump and treat technologies.
Chemical Oxidation	The contaminant's oxidation state is increased while the reactant's is lowered. The contaminants are detoxified by changing their chemical forms. For example, an organic molecule can be converted to carbon dioxide and water or to an intermediate product that may be less toxic than the original.	Chemical oxidation is implementable at Site 38. However, elevated inorganic concentrations in the poor quality groundwater may interfere with chlorinated VOC oxidation. This technology is typically used for source area remediation rather than to treat aqueous dissolved phase plumes, such as exist at Site 38.	This technology has been demonstrated to be effective in removing low concentrations of halogenated and nonhalogenated VOCs and SVOCs, PCBs, pesticides, cyanides, and volatile and nonvolatile metals. However, the process is nonselective; therefore, any oxidizable material reacts. The oxidizing agents must be well mixed with the contaminants to produce effective oxidation. An oxidized aquifer may result in precipitation or increased solubility of certain inorganic species.	Chemicals used to oxidize the contaminants can significantly increase the capital cost. This technology tends to be more cost effective for high contaminant concentrations relative to traditional pump and treat systems. Maintenance requirements are minimal.

Table 3-8
 Technology Screening for Site 38 Groundwater

Technology	Description	Implementability	Effectiveness	Cost
Electrokinetic Remediation	Heavy metals, radionuclides, and organic contaminants are separated from saturated or unsaturated soils, sludges, and sediments. A low-intensity direct electrical current is applied across electrode pairs that have been implanted in the ground on either side of the contaminated zone. Electrokinetic transport can be classified into distinct electrokinetic phenomena: (1) electrophoresis, (2) electroosmosis, and (3) electromigration. Positively charged species and water move toward the cathode; negatively charged species move toward the anode. The contaminants may be extracted and directed to a recovery system or deposited and stabilized at the electrode.	Electrokinetic remediation may not be implementable at Site 38. Since Site 38 is an industrial site, buried metallic conductors may interfere with the process and the salinity may be too high to effectively implement the technology.	This technology treats heavy metal, radionuclide, and organic contaminated GW. Pilot-scale studies have indicated removal rates of 99% or greater for TCE. The process is most effective when the CEC and the salinity are low.	The cost of electrokinetic remediation depends on specific chemical and hydraulic properties at the site. Energy consumption is directly proportional to contaminant migration rates. This technology is more cost effective for large areas of contamination.
Enhanced Biodegradation <ul style="list-style-type: none"> • nitrate enhancement • oxygen enhancement 	Enhanced biodegradation introduces natural and engineered microorganisms or oxygen-release compounds into the aquifer to promote microbial growth and accelerate natural processes. Some common additives are hydrogen peroxide, air, oxygen, methane, Fenton's reagent, nitrates, and molasses.	Enhanced biodegradation is implementable at Site 38. Treatability studies are required prior to full-scale implementation. Enhanced bioremediation is easily implemented and can use information collected for the MNA evaluation to determine in situ mechanisms requiring enhancement.	Primarily treats nonhalogenated VOCs and SVOCs, and fuel hydrocarbons. The process can be engineered to increase its effectiveness on halogenated VOCs and SVOCs. The effectiveness of enhanced bioremediation is highly site-specific and better evaluated using parameters similar to those collected for the MNA evaluation.	Bioremediation costs are typically variable since process amendments are highly site specific. However, in situ bioremediation costs are typically lower than other in situ technologies.

Table 3-8
 Technology Screening for Site 38 Groundwater

Technology	Description	Implementability	Effectiveness	Cost
Monitored Natural Attenuation	Natural subsurface processes such as dilution, dispersion, volatilization, biodegradation, adsorption, stabilization, and chemical reactions with subsurface materials are allowed to reduce contaminants to acceptable concentrations. Site conditions are managed to protect human health and the environment.	Monitored natural attenuation (MNA) is implementable at Site 38. Feasibility has been evaluated and reported in a draft technical memorandum (Appendix D). Monitored natural attenuation should only be used in low-risk situations such as at Site 38 since the aquifer is considered a poor quality groundwater source. Long-term modeling is required. State and community acceptance must be obtained.	This technology can effectively treat nonhalogenated VOCs and SVOCs. It is less effective for treating halogenated VOCs and SVOCs, unless a reducing environment exists. Biodegradation can be slow; however, given time, it is expected that the contaminants would naturally attenuate to concentrations below remedial goals. Current data indicate that MNA is taking place at Site 38.	Most costs associated with MNA are related to routine operations and maintenance (O&M) monitoring, and reporting. Capital costs might include monitoring well installation and baseline sampling activities.
Passive Reactive Barriers (PRBs)	PRBs are installed, usually in trenches, across a contaminant plume's flow path. The treatment walls are constructed of a permeable material that reacts with or acts as a catalyst for contaminant reactions (precipitation, sorption, or degradation). The reactions involve transforming the contaminants into a less toxic or less mobile form. The walls may contain metal-based catalysts to degrade VOCs, chelators to immobilize metals, nutrients and oxygen to encourage bioremediation, or other agents.	Typically, PRBs are installed down to the bottom of the aquifer. The depth to the clay layer beneath Site 38 (35 to 45 feet) makes installation difficult. In addition, the geology of the area would limit the construction to a slurry excavation otherwise running sands would likely enter the excavation and pose safety risk to construction workers on the surface via undercutting. In addition, most reactive walls are designed to treat one variety of contaminant via a specific reaction provided by a selected reagent. Site specific contaminants would require multiple reactions, which would possibly counteract each other.	PRBs are primarily designed to treat halogenated VOCs and SVOCs and inorganic compounds. They can also be used less effectively to treat nonhalogenated VOCs and SVOCs and fuel hydrocarbons. Long-term effectiveness is influenced by life span of reactive material; it may require periodic replacement. Secondary inorganics may be impacted by reaction media chemistry, precipitate out, and thus reduce wall effectiveness (i.e., it is non-selective).	Relatively high capital costs associated with barrier installation and testing. Very low O&M costs. However, PRBs require routine sampling and monitoring to measure its effectiveness.

Table 3-8
 Technology Screening for Site 38 Groundwater

Technology	Description	Implementability	Effectiveness	Cost
Phyto-remediation	Use of plants and their associated rhizospheric microorganisms to remove, contain, and/or degrade environmental contaminants in groundwater is referred to as phytoremediation. Groundwater phytoremediation includes three processes: rhizofiltration, phytotransformation, and phytostimulation. Deep-rooted trees may affect (redirect or capture) groundwater flow and thus retard contaminant migration.	Phytoremediation is implementable at Site 38. Treatability studies are required prior to full-scale implementation. Plant species are selected based on: 1) GW evapotranspiration potential, 2) the ability to produce degradative enzymes, 3) contaminant bioaccumulation rate, 4) depth of the root zone, and 5) ability to adapt to the specific climate. Though technically implementable, phytoremediation is not compatible with current and projected future land use, which is industrial. Implementation would require significant alteration of surface features and land-use patterns at Site 38.	Phytoremediation is thought to be capable of treating a wide range of contaminants, including petroleum hydrocarbons, chlorinated solvents, pesticides, metals, radionuclides, explosives, and excess nutrients. However, because it is an emerging technology, limited data are available to evaluate its overall effectiveness. Contaminants are reduced over a long period of time (years).	Costs for phytoremediation are expected to be relatively low compared to other in situ technologies. Maintenance costs are expected to be relatively low, consisting of monitoring, watering, and horticulture costs.
Ex situ Groundwater Technologies				
Bioreactors	A bioreactor treats extracted contaminated groundwater. Contaminants in groundwater contact microorganisms through attached or suspended biological systems. In suspended growth systems, such as activated sludge, contaminated groundwater circulates in an aeration basin, where a microbial population aerobically degrades organic matter. In attached growth systems, such as trickling filters, microorganisms are established on an inert support matrix to aerobically degrade groundwater contaminants.	While implementable, a bioreactor is not technically practical at Site 38 due to the low contaminant concentration in the groundwater. This well developed technology has been used for many years to treat municipal wastewater. Equipment and materials are readily available.	Biological reactors can destroy organic contaminants. However, biochemical oxygen demand (BOD) loading must be high enough to support the growth of the microbes. The low level of organic contaminants present in Site 38 groundwater would not be sufficient to support the growth of microbes. Other treatment options are more effective.	Ex situ bioremediation technologies tend to be relatively expensive compared to in situ techniques due to controls and material handling requirements. This option is not likely cost effective due to low substrate concentrations in the groundwater.

Table 3-8
 Technology Screening for Site 38 Groundwater

Technology	Description	Implementability	Effectiveness	Cost
Air Stripping	Air stripping can treat extracted contaminated groundwater at Site 38. Volatile organics are partitioned from water by greatly increasing the surface area of water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration.	Air stripping is implementable at Site 38. Inorganics in groundwater may foul equipment or clog the stripping column packing material. If this occurs, the air stripper must be taken out of service and packing material acid-washed. Groundwater will likely require pretreatment (physical/chemical treatment) prior to air stripping to remove inorganics.	Air stripping is a proven technology that would be effective in reducing volatile contaminants to below remedial goals. SVOC contaminants would be reduced, but might not meet remedial goals. Air stripping is not effective in treating inorganics, and pretreatment (coagulation/precipitation/ solids separation) must be implemented to avoid fouling.	Air stripping is moderately less expensive than other traditional pump and treat technologies. Capital costs include the column, piping, potential off-gas controls, and overall system controls. O&M costs increase if off-gas treatment is required.
Carbon Adsorption	Carbon adsorption can treat extracted contaminated groundwater at Site 38. Groundwater is pumped through canisters containing activated carbon to which dissolved contaminants adsorb.	Carbon adsorption is implementable at Site 38. Inorganics in groundwater may foul equipment or clog the carbon adsorption material. Periodic replacement or regeneration of saturated carbon is required to prevent the effluent from exceeding remedial goals.	Carbon adsorption is designed to treat halogenated and non-halogenated SVOCs. Because of carbon regeneration's high costs, carbon adsorption is sometimes used as a final polishing step with some other technology as the primary treatment.	Very high O&M costs associated with replacement and regeneration of spent carbon. Capital costs include the treatment tank, piping, and system controls.
Coagulation/precipitation and solids separation	Chemicals are added to extracted groundwater to form insoluble, agglomerated solids, with separation by settling or mechanical filtration.	Coagulation/precipitation is implementable at Site 38. As a result of separation technology, residuals are generated that require further treatment or disposal. Chemicals used for treatment can significantly increase the cost of this technology. This technology can be used as a pretreatment step prior to a primary treatment technology.	Coagulation/precipitation with solids separation is designed to treat inorganic compounds. It does not remove volatile and semivolatile organic compounds or fuel hydrocarbons effectively.	Chemicals used for treatment can significantly increase O&M costs. O&M cost also include pre- and post-treatment material handling. Capital costs are moderate compared to other traditional pump and treat systems.
Disposal	Groundwater is extracted and discharged to the FOTW where it is treated along with the sanitary sewage.	The FOTW can treat the groundwater generated at Site 38. The water must meet pretreatment standards prior to being accepted by the treatment works.	The FOTW should be able to achieve remedial goals for groundwater mixed with sanitary waste that is already being processed at the plant to acceptable discharge levels.	Costs increase if pretreatment is required.

Table 3-8
 Technology Screening for Site 38 Groundwater

Technology	Description	Implementability	Effectiveness	Cost
Reverse Osmosis	Reverse osmosis is a separation technology based on particle size. Contaminants are separated by forcing the fluid through a semipermeable membrane. Only particles smaller than the membrane openings can flow through.	Filtration is implementable at Site 38. As a result of separation technology, residuals are generated that require further treatment or disposal. This technology would likely be used as a pretreatment process prior to an organic remedial system. However, the system would produce a rejection stream equaling 30% of the influent flow that is 3 to 4 times more concentrated than the influent water.	This technology is used primarily to remove inorganics from waste streams, but can also be used to remove some organics. To meet the remedial goals, reverse osmosis may need to be followed by ion exchange as a polishing step.	Relatively expensive technology. Capital costs include the hydraulic and pressure components, tanks and piping, and the membrane filter. O&M costs include system and effluent monitoring, and sludge handling.
Ion Exchange	Ion exchange can treat extracted groundwater at Site 38. Ion exchange involves the transfer of one ion from an insoluble exchange material for a different ion in solution.	Ion exchange is implementable at Site 38. Chemicals used for regeneration may be expensive and the waste regenerant must be disposed of, increasing the cost. The expensive ion-exchange resins can be ruined if the system is not operated properly. This technology may require pretreatment prior to its use as a primary treatment.	Ion exchange is designed to treat inorganic compounds. An advantage of ion exchange is it can often remove unwanted ions preferentially including iron, manganese, and heavy metals. It does not remove volatile and semivolatile organic compounds or fuel hydrocarbons effectively. The potential saline environment would tend to mask the target metals thereby reducing the effectiveness of the system and would likely require reverse osmosis for pretreatment.	Chemicals used for treatment can significantly increase O&M costs. In addition, post-treatment process waste water handling will increase O&M. Principal capital costs include piping and tank installation and the ion exchange resin.

Technology Screening Results

Implementability, effectiveness, and cost were used to screen the technologies and select technologies for detailed evaluation. The information in the tables is from literature review, vendors, and professional experience.

Technologies retained for further consideration are listed below.

- **Containment:** Groundwater extraction
- **In situ management:** Enhanced biodegradation and monitored natural attenuation
- **Ex situ treatment:** Groundwater extraction followed by air stripping and coagulation/precipitation for inorganics pretreatment
- **Offsite disposal:** Disposal to the FOTW

No Action Alternative

The NCP requires evaluation of a no-action alternative as a basis of comparison with other remedial alternatives. Because no action may result in contaminants remaining onsite, CERCLA, as amended, requires a review and evaluation of site conditions every five years. The no-action alternative will be carried through and analyzed throughout the FS process.

Initial Screening Results

Based on the initial screening of alternatives, the following alternatives were not considered viable options and the rationale is discussed below.

- **Air Sparging** was screened from further consideration, because:
 - The technology could treat only VOCs in groundwater and would not address soluble lead or cadmium.
 - Due to aeration of the aquifer, an aerobic environment would be created that would hinder the biodegradation of PCE and TCE and could possibly mobilize some inorganics.
 - Aeration of the aquifer would result in significant fouling of the air sparging wells due to the high concentrations of iron and other inorganics in the Site 38 area. Maintenance would be a continuous concern given site geochemistry.
 - Installation of a soil vapor extraction system to meet the requirements of FAC 62-770(5)(a) would be impractical due the shallow groundwater table, thus increasing the possibility of vapor migration to surrounding buildings or through utility trenches.
- **Chemical Oxidation** was screened from further consideration for the following reasons:
 - Metal ions may cause process fouling and some may become more soluble.
 - Technology is typically used for source area remediation and is not cost effective for large dissolved phase plumes such as found at Site 38.
 - Handling and storage of oxidizers may present safety problems and/or issues, particularly given the current industrial use of Site 38.

- Byproducts of in situ oxidation, including heat and gas, may cause pavement buckling and/or offgas concerns in adjacent buildings.
- Initial capital costs are significantly higher than those of competing technologies; however, no operations and maintenance costs are associated with this technology.
- **Electrokinetic Remediation** was screened from further consideration because the contamination is already consolidated in isolated aquifer areas. In general, electrokinetic remediation is used to consolidate groundwater contamination to increase the extraction technology's effectiveness. Furthermore, this alternative is typically more effective when the CEC and salinity are low. Because the contamination at Site 38 is adjacent to a saltwater source (Pensacola Bay), its salinity would likely interfere with the remedial processes. Furthermore, sodium concentrations in the groundwater consistently exceed freshwater criteria across the site.
- **Phytoremediation** was screened from further consideration because the areas impacted at Site 38 are currently industrial use. Implementation of a phytoremediation remedy would require removing these areas from current and future projected land use, and maintaining them as horticultural areas. Phytoremediation would also result in additional exposure to soil contaminated above RGs (see Section 4).
- **Passive Reactive Barrier (PRB)** was screened from further consideration because site geology may limit its constructability. Trenching equipment can reach depths up to 20 to 25 feet below ground surface (bgs) using a one-pass technology; however, the groundwater table is very close to the surface so a significant increase in trench depth could not be achieved. A shored trench would be very difficult, and might be impossible to construct, given the high hydraulic conductivity of the aquifer, potential for running

sands, and cost to provide shoring to 35 to 40 feet bgs. Slurry (bentonite or guar) trenching, the only real potential for excavating in this environment, is not appropriate because it might leave a film over the reagent, which would likely impact the reagent's effectiveness. Moreover, trenching in the Site 38 area is expected to be impractical due to the significant number of utilities and support infrastructure, both those associated with former industrial practices in the Site 38 area and those required for ongoing activities. In addition, the target compounds would require the use of two different reactive media to meet remedial goals and each would counteract each other, potentially causing the reactive wall to be ineffective.

- **Bioreactors** were screened from further consideration because low organic contaminant concentration in Site 38 groundwater would not be sufficient to support microbial growth. Other treatment options are more effective. In addition, this technology would need to be combined with a process to remove inorganics.
- **Carbon Adsorption** was screened from further consideration because of the potential for carbon to be fouled by inorganic precipitates. Furthermore, the high cost of O&M would be prohibitive for site remediation. This technology would be most effective for treating off-gases from a SVE or air stripping system.
- **Reverse Osmosis (RO, or membrane filtration)** was screened from further consideration because it would generate a rejection flow, as a waste stream, equivalent to approximately 30% of the inflow rate to the system. Discussions with vendors indicated that this rejection flow would comprise the metal ions removed from the groundwater at concentrations 3 to 4 times more concentrated than the original treated water. The flow required to capture the plumes from the Building 71 and 604 areas is estimated 125 gallons per minute (gpm); therefore, the more concentrated rejection stream would be generated at a flow rate of 40 gpm. This results in an annual waste stream generation of

approximately 20 million gallons that would require disposal offsite or further treatment via coagulation/precipitation. In addition, vendors have indicated that this system by itself could not reduce the contaminant concentrations to below RG and would require ion exchange as a polishing step. Disposal of the water from this system offsite would exceed \$140 million and treating the groundwater via coagulation/precipitation is presented as an Alternative G4a.

- **Ion Exchange** was screened from further consideration because the brackish water quality would require frequent replacement and/or regeneration making O&M of the system difficult and expensive. In addition, saline intrusion in the aquifer would mask the target metal ions making treatment ineffective. Industry representatives have indicated that at the concentrations identified in the RI, a primary RO step would likely be required to make ion exchange feasible. However, the reverse osmosis technology has been screened from further discussion because it generates a significant volume of a more concentrated liquid waste that would add significant disposal and/or treatment costs to the remedial project.

3.4 Development and Preliminary Evaluation of Remedial Alternatives

Following identification and screening of technologies, general response actions and process options are combined to form alternatives that address the entire site. These process options were chosen as representatives of technology types. In assembling alternatives, the NCP goal of evaluating a range of alternatives was considered. In keeping with this goal, the alternatives vary in level of effort, balance of containment versus treatment measures, cost, and remediation time frame. The following alternatives have been developed.

- **Alternative G1:** No-action
- **Alternative G2:** Monitored natural attenuation
- **Alternative G3:** Enhanced bioremediation
- **Alternative G4:** Groundwater extraction and disposal to the FOTW

- **Alternative G4a:** Groundwater extraction followed by coagulation/precipitation for inorganics pretreatment and air stripping for removal of VOCs.

3.4.1 Alternative G1: No Action

The NCP requires that a no-action alternative be considered as a "baseline" against which all other alternatives will be evaluated. In the no-action alternative, no remedial action will be taken. Future site use will be uncontrolled, and, theoretically, groundwater may be used for residential purposes. It is important to note, however, that the domestic consumption pathway is incomplete, and due to the high inorganic concentrations in site groundwater it is unlikely that the surficial aquifer at Site 38 will ever be used for domestic or industrial purposes.

Because wastes would remain at Site 38, the Superfund Amendments and Reauthorization Act (SARA) requires that the data collected from the site be evaluated every five years. This evaluation would include spatial and temporal analysis of existing data to determine increasing, decreasing, or stationary trends in contaminant concentrations. The results of this evaluation would be used to maintain, increase, or decrease the number and types of samples and analysis required for the monitoring program. In addition, the need for remedial action would be re-evaluated every five years.

Implementability

This alternative is technically and administratively feasible. No construction, operation, or maintenance is required for no action. No technology-specific regulations are associated with this alternative.

Effectiveness

The no-action alternative does not reduce waste's toxicity, mobility, or volume in groundwater. However, it is expected that current conditions represent worst-case conditions and contaminant concentrations are attenuating, thus rendering groundwater less threatening with time.

Cost

NCP-required five-year monitoring costs are associated with this alternative. Costs associated with the no-action alternative are presented in Table 3-9.

Table 3-9
Alternative G1: No Action Cost

Action	Quantity	Cost	Total Cost
Groundwater sampling (field work)	110 hrs.	\$130/hr.	\$14,000
Groundwater analysis	34 samples every 5 years 6 QA/QC samples per sampling event	\$610/sample	\$24,000 ^a
Reporting/engineering	LS	20% cost	\$8,000
Miscellaneous, equipment, travel, supplies, etc.	LS	25% cost	\$10,000
Subtotal			\$56,000
Present value subtotal at 6% discount over 30 years			\$137,000^b
Alternative G1 Total			\$137,000

Notes:

(a) = Groundwater analytical samples include total metals, VOCs, and SVOCs.

(b) = Cost based on sampling event once every five years.

LS = Lump Sum

All costs are rounded to the nearest thousand dollars.

3.4.2 Alternative G2: Monitored Natural Attenuation (MNA)

MNA is a remedial alternative for organic and inorganic compounds dissolved in groundwater. The processes of natural biological degradation, advection, adsorption, dispersion, volatilization, and precipitation can effectively reduce contaminant toxicity, mobility, or volume to levels that protect human health and the environment. Where a residual source has been identified, MNA is typically used in conjunction with source control actions. Institutional controls would be required where RGs are exceeded and potential exposures may occur.

In this alternative, isolated RG exceedances (defined as detections above RGs outside the primary plume area) are monitored, as the contaminant mass associated with the exceedance is assumed to be minimal. Monitoring periodically assesses contaminant trends in the isolated area and can be used to assess whether additional measures are required.

MNA is used when:

- Active remediation is not practicable, cost effective, or when groundwater is unlikely to be used in the foreseeable future.
- MNA is expected to reduce contaminant concentrations in the groundwater to RGs in a reasonable time.
- There is little likelihood of exposure to contaminants because of existing or planned site conditions.
- Natural biodegradable daughter products of the original contaminants of concern do not accumulate.

Because surficial groundwater at Site 38 is high in naturally occurring inorganics (e.g., sodium, aluminum, iron, etc.), and because it is adjacent to Pensacola Bay, it is highly unlikely that it will ever be used for consumptive purposes. Therefore, the likelihood of exposure to contaminants is low.

To determine whether MNA can be used effectively at Site 38, the following 10 points that are presented in USEPA's directive *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites* (USEPA, 1998) were evaluated:

1. *Whether the contaminants present in soil or groundwater can be effectively remediated by natural attenuation processes.* The Navy performed an evaluation of MNA at Site 38 (Building 604 and 71) to assess whether natural attenuation was occurring in the aquifer, and if it is a viable option for degrading VOCs and lead to less harmful constituents. The results of this evaluation have shown overwhelming evidence of biological degradation of chlorinated solvents in the aquifer and a significant reduction of contaminant concentrations over time. The *Evaluation of Monitored Natural Attenuation: Site 38 (Buildings 71 and 604) NAS Pensacola* (EnSafe, 1999) presenting the data and rationale used to make this assessment is in Appendix D, and the conclusions of the MNA evaluation are presented below.

- Geochemical analysis and interpretation of groundwater results at Site 38 show that both Building 71 and 604 areas are highly conducive to natural biological degradation of chlorinated solvents.
- Measurements of dissolved oxygen (DO), oxidation-reduction potential (ORP), hydrogen, and other geochemical parameters have established the occurrence of anaerobic or reducing conditions in the aquifer, a condition which is critical for reductive dechlorination of chlorinated solvents.
- Geochemical analysis has shown overwhelming evidence to suggest the continuing degradation of PCE and TCE.
- Low detections of vinyl chloride at Site 38 suggest that this critical biological daughter breakdown product is not accumulating in the aquifer.

- Historical trends show an overall decrease in concentrations of PCE and TCE across these two areas and an overall decrease along the direction of groundwater flow.
- Lead concentrations at the site have also decreased over time in critical locations in both areas, which is attributed to favorable geochemical conditions in the aquifer. Although lead concentrations have temporarily increased at two downgradient locations in the Building 604 Area, conditions are still favorable for an overall decrease in lead that should gradually precipitate out before this metal is transported to downgradient locations.

Subsequent review of chromium and cadmium concentrations in the aquifer, with respect to the area with ongoing MNA of VOCs and lead, has indicated that aquifer geochemistry is optimal for precipitation of both compounds within the anoxic portion of the plume. Concentrations within the reducing area have decreased since the RI. While concentrations in two Building 604 downgradient locations have indicated an increase in concentrations, concentrations are lower than those quantitated during the initial RI sampling events. Conditions are still geochemically favorable for an overall decrease in cadmium and chromium that should gradually precipitate out before they are transported to downgradient locations.

2. *Whether or not the contaminant plume is stable and the potential for environmental conditions that influence plume stability will change over time.* Current data suggest that the contaminant plume is stable and that environmental conditions will not alter the plume's stability.

- MNA will irreversibly change the form of PCE, TCE, cis-1,2-DCE, and VC. Once dehalogenation occurs, chemicals are degraded and cannot resynthesize.

- Dissolved lead will be converted to lead sulfide, and will precipitate out and adsorb to the aquifer media. Under aerobic conditions with a pH greater than 6, lead carbonate compounds are dominant. The solubility of lead decreases as pH and total dissolved salt content increase. Because of these factors, lead mobility at Site 38 is expected to be minimal over the long term.
- Chromium, if present in hexavalent form, will be converted to Cr(III) by sulfide and ferrous iron. Cr(III) has low solubility at pH greater than 5, and typically precipitates out as a hydroxide or sorbs to the aquifer matrix. Cr(III) precipitation is assumed irreversible because significant oxidation/reduction changes within the aquifer would be required to dissolve the solid hydroxide. Conversion to Cr(VI) is unlikely under normal environmental conditions.
- Under reducing conditions where sulfur is present in the aquifer, cadmium will precipitate as cadmium sulfide (CdS). At pH values greater than 6, precipitation and sorption become primary transport mechanisms, but in the presence of sulfate and chloride, cadmium solubility and mobility is enhanced.^{3,4} Cadmium immobilization as CdS will only be maintained as long as reducing conditions are present. Geochemistry indicates overall conditions will remain reducing (i.e., sulfide-generating) for the foreseeable future.

³Preferential sorption of inorganics is soil-specific, and depends on cation exchange capacity, natural organic matter, mineral content, etc. However, cadmium sorption is typically preceded by lead, copper, and zinc.

⁴Note that chloride is generated during reductive dechlorination typical of MNA. Generation of chloride, though an indication of successful VOC degradation, may enhance cadmium's mobility.

3. *Whether human health, drinking water supplies, other groundwaters, surface waters, ecosystems, sediments, air, or other environmental resources could be adversely impacted as a consequence of selecting MNA as the remediation option.* Currently, there is no risk to human health, drinking water supplies, other groundwater aquifers, or air by the selection of MNA. The potential exists that contaminated groundwater could discharge to Pensacola Bay at/or above MSWQ criteria, which could adversely impact the sediments or ecosystems; however, given the assimilative capacity of the Pensacola Bay system this is not expected. Historical surface water samples do not indicate any impacts to the adjacent bay environment.
4. *Current and projected demand for the affected resource over the time period that the remedy will remain in effect.* No current or projected demand of this aquifer is anticipated over the next 30 years. Future use is unlikely due to overall poor water quality (high aluminum, iron, sodium, etc.), and the likelihood of saltwater intrusion. Currently, the area is connected to the municipal water supply system, which derives its water from Corry Station, 3 miles north of the base. To ensure that groundwater at the site is not used land use restrictions prohibiting the use of groundwater will be put in place, in accordance with the Land Use Control Assurance Plan (LUCAP).
5. *Whether the contamination, either by itself or as an accumulation with other nearby sources (on-site or off-site), will exert a long-term detrimental impact on available water supplies or other environmental resources.* No detrimental impact due to contamination at Site 38 is anticipated. Groundwater contamination does not appear to be migrating based on results of several rounds of monitoring data, and has not impacted the intermediate aquifer. Groundwater concentrations at monitoring wells along the bay (38GS02 and 38GS03) and near the dock (38GS32) have exhibited significantly reduced concentrations of VOCs since the RI; lead has only been detected in 38GS32 once, during the latest

sampling round, at 24 $\mu\text{g/L}$. Because of the low concentrations at the downgradient monitoring wells, it can be assumed that if contaminated groundwater were to discharge to Pensacola Bay, the assimilative capacity of the system would likely absorb the discharge without impacting the bay. This assumption is confirmed through surface water sampling results, which indicate no VOCs, cadmium, chromium, or lead above surface water standards.

6. *Whether the estimated timeframe of remediation is reasonable compared to time frames required for other more active methods (including the anticipated effectiveness of various remedial approaches on different portions of the contaminated groundwater).* The maximum worst case remedial timeframe of 30 years will be used throughout this FS for cost estimating purposes. However, some VOC concentrations have shown 99% to 98% removal over the past 4 to 5 years, and inorganic concentrations have shown significant reductions as well during the same period. These data indicate that 30 years may be a maximum case scenario.

7. *The nature and distribution of sources of contamination and whether these sources have been, or can be, adequately controlled.* There have been no source removal actions, as no source has been identified for VOC or inorganic contamination. Groundwater concentrations do not indicate the presence of dense, non-aqueous phase liquids (DNAPL) (i.e., concentrations do not exceed 1% of PCE, TCE, DCE, or VC aqueous solubility), and cadmium, chromium, and lead concentrations are typically significantly less than 500 $\mu\text{g/L}$. VOC contamination is clearly defined, concentrated near the Building 604 area, with isolated exceedances near the former Building 71. If necessary, hydraulic controls can be implemented to manage groundwater exhibiting the highest VOC contamination. For inorganics, there does not appear to be a clear inorganic "plume" which can be managed via hydraulic controls.

8. *Whether the resulting transformation products present a greater risk, due to increased toxicity and/or mobility, than do the parent contaminants.* As a result of biodegradation of PCE and TCE, the daughter products of DCE and VC are formed. VC is more toxic than PCE or TCE; however, this compound does not appear to be accumulating in the aquifer as a result of this transformation (EnSafe, 1999). Precipitated inorganics exhibit significantly less toxicity than dissolved species. However, the potential for enhanced cadmium mobility exists in the presence of chloride, a byproduct of the reductive dechlorination process, and in the presence of naturally occurring sulfate. Downgradient cadmium concentrations are approximately 50 $\mu\text{g/L}$.
9. *The impact of existing and proposed active remediation measures upon the MNA component of the remedy, or the impact of remediation measures or other operations/activities (e.g., pumping wells) in close proximity to the site.* MNA would be the sole remedial action performed at the site, therefore other active remedies will not impact its use.
10. *Whether reliable site-specific mechanisms for implementing institutional controls (e.g., zoning ordinances) are available, and if an institution responsible for their monitoring and enforcement can be identified.* The Navy is the sole owner of the property and it controls all surrounding property, which is part of NAS Pensacola. This is a secured environment and is patrolled by base security. The Navy, USEPA, and FDEP have developed a LUCAP for use at NAS Pensacola, which is used to implement and oversee institutional controls at the base.

Based on an evaluation of these ten points, the use of MNA appears to be implementable at Site 38. But before MNA can be implemented as a long-term remedy, additional site characterization would be required to more extensively confirm its potential for success at the site

(i.e., estimated biodegradation rates must be sufficient to prevent dissolved contaminants from completing exposure pathways or reaching a predetermined point of compliance at concentrations exceeding applicable regulatory standards or RGs). Remedial Design (RD) would provide more detailed analysis of the natural attenuation including:

- Determining groundwater flow and solute-transport parameters.
- Addressing any sources and current and future exposure points.
- Comparing transport rates to attenuation rates.
- Development of a long-term monitoring plan.

A long-term groundwater monitoring plan is used to assess plume migration over time and to verify that MNA is occurring at rates sufficient to protect potential downgradient receptors. Long-term sampling frequency depends on groundwater flow velocity, the location of the point-of-compliance monitoring well(s), and other regulatory issues considered during risk management decision making. If MNA does not meet remedial requirements during long-term monitoring, other remedial technologies may be implemented to assist or replace it.

Implementability

This alternative is technically feasible based on the results of the Evaluation of Monitored Natural Attenuation Memorandum and the evaluation of the ten points identified in USEPA's directive on MNA. It must be screened during remedial design (RD) to determine if MNA can effectively reduce contaminants to concentrations that protect human health and the environment within a reasonable timeframe. No construction, operation, or maintenance would be initially required. The plume and RG exceedances can be monitored using existing monitoring wells. However, additional monitoring wells might need to be constructed and maintained during long-term monitoring. No technology-specific regulations would apply.

This alternative is administratively feasible. Site 38 can be designated an industrial area and the use of the groundwater beneath the site can be restricted with institutional controls. If MNA can be shown to reduce contaminants in a reasonable time, regulatory concurrence is likely. Community acceptance would need to be obtained and would require educating the general public on the difference between no action and MNA.

Effectiveness

Protection of human health and the environment in the short-term is accomplished by institutionally controlling exposure to site groundwater and its use. This alternative requires current use of the site as an industrial area to continue for the foreseeable future; land and groundwater-use restrictions can be implemented. Should Site 38 property use change, the site may need to be re-evaluated.

Long-term effectiveness of natural attenuation processes would be accomplished through the reduction of contaminant toxicity, mobility, and volume through the processes of biodegradation, advection, adsorption, dispersion, volatilization, and precipitation. As discussed in Appendix D, sulfate-reducing and methanogenic conditions are present in the central part of the Building 604 area, where the RI had quantified high VOC concentrations. Contaminant concentrations between 1994/1995 and 1998/1999 decreased significantly, in many locations to concentrations at or below RGs. Inorganic contaminant concentrations also have dropped sharply in the majority of Building 604 wells. Empirical data strongly suggest the effectiveness of MNA in this area. Similarly, at Building 71, concentrations have decreased sharply in 38GS12; RI concentrations in 38GS13 were only slightly above RGs, and this well was not sampled in 1998/1999 events. Conditions are strongly sulfate-reducing across the Building 71 area, and again suggest reductive dechlorination is effective. Inorganic attenuation is also significant. The only concern in the Building 604 and Building 71 areas is the potential for enhanced mobility of cadmium due to the

presence of sulfate and chlorides, but as long as the aquifer exhibits reducing conditions, migration potential may be minimal.

Restoration of site groundwater to RGs, which might be accomplished upon completion of the MNA program, would reduce groundwater to below RGs for nonambient compounds. This alternative may reduce contamination below RGs, but the amount of time required for complete attenuation is not known. Significant attenuation has been demonstrated over the past 4 to 5 years; these data suggest remedial timeframes may be less than the 30 year period assumed for this scenario. Contaminants at the plume's downgradient boundary (defined by 38GS02, 38GS03, and 38GS32) are within one order of magnitude of unrestricted use RGs.

Monitoring of RG exceedances does not effectively reduce contaminant concentrations in groundwater. However, monitoring does provide data that can be used to measure contaminant mobility, degradation, dispersion, and thus verify the effectiveness of natural attenuation.

Cost

Cost components for the MNA alternative would include the following (shown in Table 3-10):

- Remedial design — including a complete round of groundwater sampling in the Site 38 area to assess current conditions and select monitoring wells for use during the MNA remedy.
- Selection of wells outside the MNA area which will be monitored due to RG exceedances.
- First year "startup" program — including one year of quarterly data to evaluate seasonal variation of contaminants.
- Annual monitoring program — assuming one sampling event per year after the first year.
- Institutional controls — includes a LUCAP to restrict groundwater use in the Site 38 area.

Table 3-10
 Alternative G2: MNA Costs

Action	Quantity	Cost	Total Cost
Remedial Design Event			
Groundwater sampling (field work)	90 hrs.	\$130/hr	\$12,000
Groundwater analysis	30 samples 10 QA/QC	\$610/sample	\$24,000
Evaluation (includes fate-and-transport modeling)	260 hrs.	\$94/hr	\$24,000
Reporting/engineering	LS	20% cost	\$12,000
Misc: equipment, travel, supplies, software, etc.	LS	25% cost	\$15,000
RD Subtotal			\$87,000
MNA Implementation: First Year			
Groundwater sampling (field work)	60 hrs/event	\$130/hr	\$24,000
Groundwater analysis	20 samples per quarter (over 1 year) 7 QA/QC per sampling event	\$610/sample	\$64,000*
Institutional controls	LS	\$50,000	\$50,000
Reporting/engineering	LS	20% cost	\$18,000
Misc: equipment, travel, supplies	LS	25% cost	\$22,000
Implementation Subtotal			\$178,000
Remedial Action Contractor			
Overhead, Operations, and Profit			\$100,000
Total Capital (Startup) Costs			\$272,000
MNA long-term monitoring annual program			
Groundwater sampling (field work)	60 hrs.	\$130/hr.	\$8,000
Groundwater analysis	20 samples per year 7 QA/QC per sampling event	\$610/sample	\$16,000
Evaluation/Project Management	120 hrs.	\$94/hr	\$11,000
Reporting/engineering	LS	20% cost	\$7,000
Misc. equipment, supplies, travel	LS	25% cost	\$9,000

Table 3-10
Alternative G2: MNA Costs

Action	Quantity	Cost	Total Cost
Monitoring Program Subtotal			\$51,000
Monitoring Program Present value (subtotal at 6% for 30 years)			\$702,000
Alternative G2 Total			\$1,061,000

Notes:

(*) = Groundwater analytical samples include total metals, VOCs, and geochemical parameters.
 LS = Lump Sum
 Costs are rounded to the nearest \$1,000 and are considered to be Maximum Case Scenarios

3.4.3 Alternative G3: Enhanced Bioremediation

If the MNA assessment indicates contaminant degradation via natural processes is too slow, or if toxic end products are accumulating, bio-enhancement may be used to improve degradation. Numerous technologies and products are currently available to enhance aquifer conditions, including oxidizing and reducing agents, supplemental nutrients, engineered microbial populations, etc.

Current data suggests that complete degradation is occurring, as vinyl chloride is not accumulating onsite, and several wells have exhibited concentration reductions to below detection limits since the 1994 RI. However, it is possible that degradation mechanisms could stall. If contaminant trends indicate decreased rates of attenuation (and/or increases in concentration), enhancement would be evaluated.

If groundwater conditions suggest that the aquifer is not reducing enough to support reductive dechlorination (particularly of 1,2-DCE and vinyl chloride), supplemental carbon in or upgradient of source areas may be used to manipulate oxidation/reduction conditions within the aquifer. Addition of molasses or similar simple-sugar solutions increases total organic carbon concentrations within the aquifer, thus enhancing microbial activity and depleting dissolved

oxygen.⁵ Enhancement would attempt to maintain oxidation/reduction conditions in the sulfate-reducing or methanogenic range (ORP approximately -200 millivolts [mV] or less). At this time, it is assumed that essential nutrients are present in sufficient quantities to sustain reductive dechlorination.

Alternatively, if higher-order chlorinated compounds were degrading and data indicated accumulation of vinyl chloride, aquifer enhancements could include addition of oxygen. Vinyl chloride, though the most difficult to degrade via reductive dechlorination (because it is the daughter product exhibiting the lowest oxidation state), has been shown to be a primary substrate under aerobic conditions. Aerobic enhancement could include active injection of compressed air similar to biosparging, or use of passive oxygen delivery devices.⁶

An in situ biological remedy would require the following elements:

- Pilot study of enhanced bioremediation techniques, to determine the correct amendment addition rate and frequency. Other factors to be evaluated include well spacing, well screen length, etc.
- Injection or delivery devices. Five wells are estimated for each impacted area, for a total of 10 wells at Site 38.
- Injection will be performed manually on a set schedule, e.g., once per month. Molasses will be pumped down the well casing, and forced into the aquifer using compressed air.

⁵Various passive oxygen-reduction devices are available, such as "socks" which are installed within a well casing. The feasibility of such passive devices will be examined during remedial design, to determine the most cost-effective and implementable approach for Site 38. This FS identifies oxygen reduction as a general technology approach, as possible and implementable.

⁶Oxygen delivery devices, as with passive oxygen reducing devices, are commercially available and their application will be evaluated during remedial design, if appropriate. This FS identifies the general approach as feasible.

For estimating purposes, approximately 1 gallon of molasses will be injected per well per month.

- Bimonthly monitoring of aquifer geochemistry to evaluate enhancement processes.
- Quarterly monitoring of site contaminant trends for the first year, with a First Year report. Annual evaluation of analytical data for trends thereafter, with subsequent report submittal.

Implementability

Enhanced bioremediation is implementable at Site 38. Natural biodegradation mechanisms are clearly ongoing within the aquifer, and bioenhancement may be achieved easily. Additional monitoring information will be required from Site 38 wells, but these data are the same as those acquired during the design-phase of MNA and the first year of implementation. Should data indicate problems with MNA, it will be relatively easy to modify the design for enhanced bioremediation. Pilot-scale studies will be required to determine the appropriate amendments, injection well configuration, and injection rate. The system can be designed to minimize the degree of O&M required. Enhanced bioremediation's effectiveness can be monitored using existing wells, or if necessary new monitoring points can be installed with relative ease.

This alternative is administratively feasible. Site 38 can be designated an industrial area and the use of groundwater beneath the site can be restricted with institutional controls. Degradation rates can be enhanced with amendment addition. Regulatory concurrence is likely.

Effectiveness

Protection of human health in the short term is accomplished by institutionally controlling exposure to site groundwater and its use. This alternative, as with MNA, would require current use of the site as an industrial area to continue for the foreseeable future: land and groundwater-use restrictions can be implemented. Should Site 38 property use change, the site may need to be re-evaluated.

Long-term effectiveness of enhanced bioremediation processes would be accomplished through the reduction of contaminant toxicity, mobility, and volume through active, engineered degradation processes. An engineered bioremediation system could enhance sulfate-reducing and methanogenic processes identified in the central parts of the Building 604 and Building 71 areas. Alternatively, if vinyl chloride begins to accumulate in the aquifer, oxidative enhancements can be used to modify the oxidation/reduction state of the aquifer and enhance aerobic removal of vinyl chloride.

Restoration of site groundwater would reduce groundwater to below RGs for non-ambient compounds. Remedial timeframes for an enhanced bioremediation system are unknown, but can be quantified following remedial design. It is expected that enhanced bioremediation would be faster than natural processes, which have demonstrated complete degradation in several wells since the RI.

Monitoring of RG exceedances does not effectively reduce contaminant concentrations in groundwater. However, monitoring does provide data that can be used to measure contaminant mobility, degradation, and dispersion, and thus verify the effectiveness of natural processes outside the active remediation area.

Cost

Cost components for the enhanced bioremediation alternative would include the following (shown in Table 3-11):

- Remedial design — including a complete round of groundwater sampling in the Site 38 area to assess current conditions and determine which bioenhancements require pilot study.
- Pilot study — including installation of test and monitoring wells, monitoring, and subsequent data analysis.

- Development of a monitoring program which will monitor select wells outside the active remediation area exhibiting RG exceedances.
- Installation and startup — initial optimization of the bioremediation system.
- Annual monitoring program — assuming quarterly sampling the first year, and then one sampling event per year thereafter.
- Institutional controls — includes a LUCAP to restrict groundwater use in the Site 38 area.

Table 3-11
Alternative G3: Enhanced Bioremediation Costs

Action	Quantity	Cost	Total Cost
Remedial Design Event			
Groundwater sampling (field work)	90 hrs.	\$130/hr	\$12,000
Groundwater analysis	30 samples 10 QA/QC	\$610/sample	\$24,000
Pilot Test Wells	4 wells	\$1,500/well	\$6,000
Pilot Test Supplies	LS	\$5,000	\$5,000
Pilot Test Implementation	80 hrs.	\$130/hr	\$10,000
Evaluation (includes fate-and-transport modeling)	320 hrs.	\$94/hr	\$30,000
Reporting/engineering	LS	20% cost	\$17,000
Misc: equipment, travel, supplies, software, etc.	LS	25% cost	\$22,000
Subtotal			\$126,000
Enhanced Bioremediation: First Year			
Injection Wells	10 wells	\$1,500/well	\$15,000
Truck, tanks compressor, generator, piping	LS	\$50,000	\$50,000
Molasses	12 applications (1/month)	\$100/application	\$1,200
Nutrients	12 applications	\$100/application	\$1,200

Table 3-11
Alternative G3: Enhanced Bioremediation Costs

Action	Quantity	Cost	Total Cost
Groundwater sampling (field work)	60 hrs/event	\$130/hr	\$24,000
Groundwater analysis	20 samples per quarter (over 1 year) 7 QA/QC per sampling event	\$610/sample	\$64,000*
Institutional controls (not included in engineering costs)	LS	\$50,000	\$50,000
Reporting/engineering	LS	20% cost	\$31,000
Misc. equipment, travel, supplies	LS	25% cost	\$39,000
Subtotal			\$275,000
Remedial Action Contractor			
Overhead, Operations, and Profit			\$100,000
Total Capital (Startup) Costs			\$501,000
O&M and Maintenance Costs			
Groundwater sampling (field work)	60 hrs.	\$130/hr.	\$8,000
Groundwater analysis	20 samples per year 7 QA/QC per sampling event	\$610/sample	\$16,000
Molasses	12 applications/year	\$100/application	\$1,200
Nutrients	12 applications/year	\$100/application	\$1,200
Onsite Labor/Monitoring	40 hrs/month	\$50/hr	\$24,000
Evaluation/Project Management	160 hrs.	\$94/hr	\$15,000
Reporting/engineering	LS	20% cost	\$13,000
Misc. equipment, supplies, travel	LS	25% cost	\$16,000
O&M Subtotal			\$94,000
O&M Present Value Subtotal (at 6% for 30 years)			\$1,294,000
Alternative G3 Total			\$1,795,000

Notes:

(*) = Groundwater analytical samples include total metals, VOCs, and geochemical parameters.

LS = Lump Sum

Costs are rounded to the nearest \$1,000 and are considered to be Maximum Case Scenarios

3.4.4 Alternative G4: Groundwater Extraction and Disposal to the FOTW

The overall objective of the groundwater recovery system is containment of groundwater in which contaminants exceed RGs and mass removal from the aquifer. The objective of monitoring exceedances is to determine fluctuations in contaminant concentrations over time to ascertain contaminant degradation, mobility, and dispersion rates.

Groundwater recovery is possible using a variety of extraction well configurations. Only one extraction well would be required to collect groundwater at Building 604, and one more in the Building 71 area to capture groundwater in that area. Preliminary plume recovery has been modeled using CAPZONE and GWPATH. A more thorough explanation of the groundwater modeling and recovery system developed for this site is presented in Appendix E, Site 38 Groundwater Recovery System Calculations. This modeling effort is intended to demonstrate the feasibility of groundwater recovery and is not a final design.

Figure 3-13 illustrates the location of each proposed extraction well and the capture zones. The Building 604 area well pump rate is 75 gpm, and the Building 71 area well pump rate is 50 gpm. At these rates, one pore volume underlying the Building 604 area surficial aquifer is captured in one year, and one pore volume of the surficial aquifer under the Building 71 area is captured in 180 days.

In this alternative, treated groundwater would be discharged to the FOTW through the sanitary sewer system. The FOTW should have sufficient capacity for the maximum projected 125 gpm flow rate from both the Building 604 and 71 areas. The FOTW has provided a copy of discharge limits historically applied to Building 604 wastewater; site groundwater may meet these limits, which are shown in Table 3-12. To determine whether site groundwater will meet discharge limits, a full groundwater sampling round is recommended as the initial phase of RD. Once data have been obtained from the sampling round and from the aquifer pumping tests, application for pretreatment standards can be made. It is assumed that the standards presented in Table 3-12 will be revised to account for current Building 604 use and Site 38 groundwater. It is assumed for this FS that the FOTW can accept a direct discharge of the groundwater pumped from the Building 604

and 71 areas. If it is determined during RD that the groundwater cannot be discharged directly to the FOTW, then pretreatment of the flow would be required. An alternative including pretreatment is presented as Alternative G4a.

Implementability

Site 38 conditions are amenable to a groundwater recovery system for capture of the contaminated groundwater plume. Groundwater extraction as a remedial alternative is viable technically. Operations would be expected to be reliable and require little maintenance. Groundwater recovery is administratively feasible, as it is commonly employed as a remedial alternative. Given the proximity of Site 38 to Pensacola Bay, it is highly likely that groundwater extraction may induce migration of the groundwater/saltwater interface inland, toward the recovery wells. Extraction rates should be minimized to reduce the chance of saline intrusion.

Preliminary review of historical Building 604 discharge criteria suggest that groundwater may meet these criteria, assuming some dilution will occur during pumping. However, a full groundwater sampling event is recommended to determine current groundwater conditions, as well as groundwater sampling during the aquifer test to determine average concentrations over a 24- or 48-hour period. These data can be used during RD to apply for new, revised discharge standards for the Site 38 area.

Effectiveness

Groundwater extraction and discharge offers additional protection for current and future site workers when combined with the use of institutional controls and routine monitoring and sampling. Contaminated groundwater would be effectively contained and removed. This alternative would reduce the toxicity and mobility of the contaminated groundwater by extracting it from the aquifer; contaminants would be treated at the FOTW. Currently, it is difficult to estimate the volume of water that would need to be extracted and removed to achieve adequate contaminant containment. It is assumed that groundwater extraction will continue for five years.



Table 3-12
Current Pretreatment Standards for Building 604 Wastewater

Contaminant	1-Day Maximum (mg/L)	Maximum Monthly Average (mg/L)
Cadmium	0.26	0.1
Chromium	1.06	0.65
Copper	1.29	0.79
Lead	0.26	0.16
Nickel	1.52	0.91
Silver	0.16	0.09
Zinc	1.0	0.57
Cyanide	0.46	0.25
TTO	0.81	—
Oil & Grease	20	10
TSS	22.93	11.85
pH	6.0 to 9.0	6.0 to 9.0

Notes:

TTO = Total toxic organics
 TSS = Total suspended solids
 mg/L = milligrams per liter

Cost

The costs are based on one extraction well in each of the Building 604 and 71 areas with a combined flow rate of 125 gpm and includes capital, annual operation and maintenance, and discharge costs. Cost analysis is based on preliminary data and modeling for feasibility purposes and cannot be considered a final design. Costs are summarized in Table 3-13. This alternative is expected to take five years to complete; cost calculations reflect this remedial time frame. However, this remedial time frame, while realistic, does not indicate the maximum case scenario. Groundwater containment could last for ten years or longer depending on aquifer characteristics and contaminant transport mechanisms. The cost to discharge to the FOTW was based on a unit

price cost of \$4.56 per thousand gallons given to the Navy by the FOTW operator. This results in a present worth of disposal at \$1,264,000 over a 5 year period at a discount rate of 6%.

Table 3-13
Alternative G4: Groundwater Recovery and Discharge Costs

Action	Quantity	Cost	Total Cost
Capital Costs			
Aquifer test	1	\$30,000 / each	\$30,000
Extraction well construction	2	\$5,000 / well	\$10,000
Pumps and switches	2	\$3,000 / pump	\$6,000
Piping and connections/excavation and backfill	LS	\$20,000	\$20,000
Institutional controls	LS	\$50,000	\$50,000
Engineering support/report preparation	LS	20% cost	\$23,000
Misc. Supplies, equipment, travel	LS	25% cost	\$29,000
Subtotal			\$163,000
Remedial Action Contractor			
Overhead, Operations, and Profit			\$100,000
Total Capital (Startup) Costs			\$263,000
Annual operation and maintenance costs			
Maintenance	12 months	\$1,000 / month	\$12,000
Electricity	10,000 kwhr	\$.07 / kwhr	\$1,000
Replacement pumps	2	\$3,000 / pump	\$6,000
Permitting/engineering support	LS	20% cost	\$4,000
Misc. equipment, supplies, travel, etc.	LS	25% cost	\$5,000
FOTW	65,700	\$4.56/1000 gal.	\$300,000
O&M Subtotal			\$328,000
Annual Monitoring Costs			
Sampling Labor	80 hours	\$130.00 / hr	\$11,000
Laboratory	34 samples plus 6 QA/QC samples	\$610.00 / sample	\$25,000
Engineering support / report preparation	LS	20%	\$7,000
Misc. equipment, supplies, travel, etc.	LS	25%	\$9,000

Table 3-13
 Alternative G4: Groundwater Recovery and Discharge Costs

Action	Quantity	Cost	Total Cost
Monitoring Subtotal			\$52,000
Annual O&M and Monitoring Subtotal			\$380,000
Present value cost at 6% discount over 5 years			\$1,601,000
Alternative G4 Total			\$1,864,000

Notes:

* = Groundwater analytical samples include total metals, VOCs, and SVOCs.
 LS = Lump Sum
 kwhr = kilowatt hour
 gal = gallons
 All costs rounded to nearest \$1,000.

3.4.5 Alternative G4a: Groundwater Extraction and Air Stripping with Inorganics Pretreatment

Under this alternative, groundwater would be extracted using the same methodology and rationale as presented in Alternative G4. However, the extracted groundwater would be treated at a centralized location using coagulation/precipitation to remove the inorganics. Next the water would be treated using air stripping to remove volatile organics, and would finally be discharged directly to the FOTW. The inorganics must be treated first to avoid equipment fouling and process complications. Following air stripping, the treated groundwater would be discharged to the FOTW through the sanitary sewer system. The FOTW can handle the maximum projected flow rates. Effluent concentrations of the treatment system would be required to meet FOTW pretreatment requirements. Each treatment process required to meet the FOTW pretreatment limits is discussed below.

- **Pretreatment: Coagulation/Precipitation:** Removal of primary and secondary heavy metals — arsenic, cadmium, chromium, lead, iron, aluminum, and manganese — might be required. The treatment technology most frequently used is coagulation, precipitation, and filtration. Such technologies are proven, effective, and implementable at Site 38. The

sludge generated by this treatment technology would require dewatering (such as by filter press) to increase solid contents before disposal. Other pretreatment options were evaluated during the technology screening phase of this FS, but all proved to be more complex and more costly than coagulation/precipitation given wastestream characteristics, primarily aquifer salinity.

- *Primary Treatment: Air Stripping:* Air stripping is an established technology, and is effective for groundwater remediation. Volatile organics are partitioned from groundwater by increasing the surface area of the contaminated water exposed to air. Types of aeration methods include packed towers, diffused aeration, tray aeration, and spray aeration. Tray aeration has been preliminarily selected for Site 38. Off-gas treatment might be required for VOCs generated at the air stripper, but preliminary calculations show mass transfer rates are less than allowed by Florida Air Pollution Rules 62-210 and 62-296 for Escambia County. Treated groundwater could be disposed of offsite through the FOTW or Pensacola Bay.

Implementability

Site 38 conditions are amenable to a groundwater recovery system to capture the contaminated groundwater plume. Groundwater extraction as a remedial alternative is technically viable. Operations would be expected to be reliable and require little maintenance. Groundwater recovery is administratively feasible, as it is commonly employed as a remedial alternative. Given the proximity of Site 38 to Pensacola Bay, it is highly likely that groundwater extraction may induce migration of the groundwater/saltwater interface inland, toward the recovery wells. Extraction rates should be minimized to reduce the chance of saline intrusion.

The groundwater treatment process selected for this alternative is both technically and administratively feasible at Site 38, and is considered the best demonstrated technologies for the

metal ions lead, arsenic, and cadmium (GWRTAC, 1997). The implementation of both air stripping for VOCs and coagulation/precipitation treatment system for inorganics at the site is technically feasible. Specific groundwater characteristics to be determined before design and implementation are flow rate, treatability studies, influent concentrations, and effluent criteria.

A monitoring system should be instituted to measure process operating efficiencies of the treatment system. Various designs of physical-chemical, air stripping, and offgas treatment equipment are readily available from vendors. Offgas treatment units are available for lease or for purchase.

The groundwater pump-and-treat system is administratively feasible. Pump-and-treat systems have historically been used to remediate contaminated aquifers. Administrative requirements would include obtaining offsite transportation permits for treatment and/or disposal of the solids generated by the treatment process. Any sludge generated from the treatment process would be disposed of at an offsite landfill. Solids exhibiting the toxicity characteristic would have to be disposed of offsite as a hazardous waste. Air pollution standards would be met using offgas controls (such as carbon adsorption) before release of the air-stream to the environment.

Discharge to the FOTW is technically and administratively implementable. A delivery and piping connection to the sanitary sewer can be constructed to discharge extracted groundwater. Sampling treated groundwater effluent might be necessary to meet FOTW discharge requirements. If discharge to the FOTW is not possible, pretreatment, and National Pollutant Discharge Elimination System (NPDES) discharge options might be considered.

Effectiveness

The groundwater extraction, treatment, and discharge alternative offers additional protection for current and future site workers when combined with institutional controls and sampling and monitoring. Contaminated groundwater would be effectively contained and removed. This

alternative would reduce the toxicity and mobility of the contaminated groundwater by eliminating it from the aquifer. Furthermore, the waste volume would be reduced using air stripping and its associated physical/chemical treatment system. Organic constituents would be transferred to the atmosphere (if the concentrations meet air regulations) or consolidated on another media (e.g. activated carbon). The inorganic compounds would be consolidated as a sludge, which would need to be dewatered and disposed of offsite potentially as a hazardous waste.

Air stripping combined with precipitation/coagulation is highly effective for contaminant treatment at Site 38, and chemical precipitation is considered the best demonstrated available technology for the metal ions lead, arsenic, and cadmium (GWRTAC, 1997). The treatment process would effectively remove contaminants to concentrations below discharge limits.

Monitoring of exceedances does not effectively reduce contaminant concentrations in groundwater. However, monitoring does assess remedy performance.

Cost

The costs, which are based on two extraction wells with a combined flow rate of 125 gpm, includes capital, annual operation and maintenance, and treatment. Cost analysis is based on preliminary data and modeling for feasibility purposes, and not a final design. Costs for groundwater treatment are summarized in Table 3-14.

Table 3-14
Alternative G4a: Precipitation/Coagulation and
Air Stripping System Treatment Costs

Action	Quantity	Cost	Total Cost
<i>Coagulation/Precipitation Capital Costs</i>			
Building	1S	\$150,000	\$150,000
Clarifier with concrete slab	1	\$105,000	\$105,000

Table 3-14
Alternative G4a: Precipitation/Coagulation and
Air Stripping System Treatment Costs

Action	Quantity	Cost	Total Cost
Tanks	LS	\$10,000	\$10,000
Pumps, piping, and accessories	LS	\$100,000	\$100,000
Process controls	LS	\$5,000	\$5,000
Sludge Dewatering Equipment	LS	\$50,000	\$50,000
Engineering	LS	20%	\$104,000
Contingency	LS	25%	\$130,000
Coagulation/Precipitation Subtotal			\$654,000
Air Stripping System Capital Costs			
Treatment System	LS	\$170,000 / each	\$170,000
Engineering	LS	20%	\$34,000
Contingency	LS	25%	\$43,000
Air Stripping Subtotal			\$247,000
Remedial Action Contractor			
Overhead, Operations, and Profit			\$100,000
Total capital costs			\$1,001,000
Annual O&M Costs			
Physical/chemical process (including Sludge Disposal)	LS	\$65,000	\$65,000
Air stripping process	LS	\$10,000	\$10,000
Full-time Operator Burdened	LS	\$100,000	\$100,000
Annual O&M Subtotal			\$175,000
Present Value Cost at 6% discount over 5 years			\$737,000
Treatment System Cost			\$1,738,000

Notes:

LS = Lump Sum

cy = cubic yard

All costs are rounded to the nearest \$1,000.

The total cost, then for groundwater extraction, treatment, and discharge (including monitoring) for Alternative 4a is \$3.6 million, including \$1.26 million in capital costs, and \$558,000 per year for system O&M.

3.5 Detailed Development and Evaluation of Remedial Alternatives

The following sections analyze the groundwater alternatives presented in Section 3.5. Each alternative is evaluated according to the criteria discussed in Section 2.4. Criteria have been divided into three categories — threshold, balancing, and modifying.

3.5.1 Alternative G1: No-Action

The no-action alternative for Site 38 involves no active remedial effort. No actions would be taken to contain, remove, or treat groundwater contamination. Groundwater would remain in place to attenuate according to natural biotic and abiotic processes. No engineering or institutional controls would be constructed. The no-action alternative provides a baseline against which other alternatives are compared.

Threshold Criteria

The alternatives must meet two threshold criteria to be considered in the FS: overall protection of human health and the environment and compliance with ARARs.

Overall Protection of Human Health and the Environment

The no-action alternative provides no additional protection of human health and the environment. Groundwater concentrations at Site 38 exceed RGs under the no-action scenario, and these exceedances would remain; it is assumed that current groundwater contamination is "worst case" and attenuating. The surficial/sand-and-gravel aquifer is not used as a potable water source and is separated from the main producing zone, the primary source of potable water in the region, by

an aquitard. Given the brackish water quality and proximity to Pensacola Bay, use of the surficial aquifer at Site 38 as a potable or an industrial source is not likely in the foreseeable future.

The no-action alternative does not afford any long-term effectiveness and permanence under an industrial scenario beyond natural degradation of constituents. No short-term impacts are associated with this alternative, which does not reduce the mobility or volume of contaminants at Site 38, but rather allows contaminant natural attenuation to be monitored every five years. This alternative does not comply with chemical-specific ARARs and TBC criteria because groundwater exceeding RGs could theoretically be consumed under an uncontrolled use scenario. However, groundwater consumption is not likely, as previously mentioned.

Compliance with ARARs

Alternative G1 does not comply with the chemical-specific ARARs developed in Section 9.1. Groundwater in which contaminants exceed RGs would remain. FAC 62-777 is TBC for Site 38. No location- or action-specific ARARs are triggered by the no-action alternative.

Balancing Criteria

The primary balancing criteria are the technical criteria on which the detailed analysis is based.

Long-term Effectiveness and Permanence

Degradation of site contaminants is left to natural attenuation processes in this alternative, and the long-term effectiveness of the no-action alternative is minimal. Currently, it appears as if a reducing environment exists in the aquifer, biodegradation of PCE and TCE and precipitation of chromium, cadmium, and lead will be promoted. Significant reductions in chemical concentrations in the aquifer have been observed over the past few years. However, the no-action alternative does not reduce the magnitude of residual risk and provides no means for monitoring. This alternative lacks treatment actions that would provide permanence.

Controls currently in place at the site — which include military security and limited site access and use — would remain, which eliminates access to the general public and development. Due to the abundant supply of high quality water in the deeper main producing zone, groundwater from the surficial zone is not used as a potable water source in southern Escambia County, nor is it expected to be used for that purpose in the foreseeable future; and therefore the possibility of the risk pathway being completed is likely negligible.

Reduction of Toxicity, Mobility, or Volume Through Treatment

The no-action alternative would not reduce the mobility or volume of groundwater contaminants at Site 38; however, toxicity and volume may be reduced slowly through natural attenuation. Contaminants would remain onsite and would not be treated during remedial actions. However, intrinsic remediation processes (either biotic or abiotic degradation) would continue and are considered irreversible. Contaminated groundwater would migrate according to current transport dynamics.

Short-term Effectiveness

Short-term effectiveness assesses the effects of an alternative on human health and the environment while the remedial alternative is being implemented. No implementation concerns are associated with the no-action alternative. No risk is posed to the community, workers, or the environment during implementation. This alternative may be implemented immediately and continue indefinitely. There are no implementation risks associated with Alternative G1.

Implementability

The no-action alternative is technically feasible and easily implemented. No construction, operation, or reliability issues are associated with this alternative. Current access controls — including military security and limited access to personnel — have historically been reliable. No

administrative coordination is required for implementation of the no-action alternative, which would not require offsite services, materials, specialists, or innovative technologies.

Cost

Costs associated with the no-action alternative include groundwater monitoring and report preparation every five years for 30 years. Each sampling and reporting event is estimated at \$52,000, with a present worth for the 30-year period of \$127,000.

Modifying Criteria

The modifying criteria are assessed formally after the public-comment period. However, the criteria are factored into the identification of the preferred alternative as far as they are known.

State/Support Agency Acceptance

FDEP and USEPA are involved in a partnering team process with the Navy and both agencies will have the opportunity to review and comment on the proposed plan.

Community Acceptance

Community acceptance for the no-action alternative would be established after the public comment period.

3.5.2 Alternative G2: MNA

Under this alternative, contaminated groundwater is left in place. The MNA alternative includes initial biodegradation assessment and fate-and-transport modeling to predict expected contaminant concentrations over time. Additional groundwater sampling would be required in support of this modeling. A long-term groundwater monitoring program would be implemented to assess the progress of MNA and to ensure that human health is protected. Institutional controls would be

implemented with land-use restrictions that limit land to industrial use, and restrict groundwater use beneath and downgradient of the site.

Threshold Criteria

Overall Protection of Human Health and the Environment

Under an industrial scenario, MNA addresses the long-term effectiveness and permanence criterion by preventing exposure to the contaminant source. Given the aquifer's overall poor water quality and its proximity to Pensacola Bay, it is an unlikely source of potable water in any future land use scenario. Protection of human health is accomplished by restrictions on groundwater use and attenuation of contaminant concentrations over time. No short-term impacts would be associated with this alternative. This alternative would likely comply with chemical-specific ARARs if aquifer chemistry is sufficient to sustain reductive dechlorination. This alternative would not be implemented if initial modeling and screening determined that RGs or protection of human health are not met.

As previously discussed, no threats to Pensacola Bay have been identified. Protection of the environment and Pensacola Bay could be further monitored through MNA.

Compliance with ARARs

The MNA alternative is intended to comply with the chemical-specific groundwater ARARs. Modeling and groundwater sampling is intended to document degradation of contaminants over time. FAC 62-777 is TBC for Site 38.

No location or action-specific ARARs would be triggered by Alternative G2.

Balancing Criteria

Long-term Effectiveness and Permanence

The MNA alternative eliminates residual risk to site workers by managing Site 38 as an industrial area and preventing groundwater from being used as a potable source through institutional controls. The Navy has performed an initial study of the aquifer to determine if MNA processes are ongoing. The study indicates overwhelming evidence that MNA is a feasible and effective option which would provide long-term, permanent aquifer remediation. However, this would need to be confirmed during RD using data from all site wells. The consumption of contaminated groundwater would be controlled institutionally (through the LUCAP) and groundwater would be monitored until remedial goals are met.

Any controls currently in place onsite — including military security and limited access to the site — would remain. These controls are considered reliable for protecting human health, given the current and projected land use onsite.

Reduction of Toxicity, Mobility, or Volume Through Treatment

MNA reduces the volume and toxicity of impacted groundwater through natural biological processes.⁷ Contaminants would remain in place onsite. Biological degradation is considered irreversible. Contaminated groundwater would migrate according to current transport dynamics.

Short-Term Effectiveness

No implementation concerns are associated with MNA. The community is protected through groundwater restrictions and institutional controls. Workers are protected by groundwater restrictions, equipment, and training. This alternative could be executed as soon as land-use restrictions and groundwater restrictions are in place. No implementation risks are associated with Alternative G2.

⁷At some sites toxicity may be increased due to degradation of contaminants to more toxic forms, such as the transformation of TCE to VC, but current data do not indicate the accumulation of VC in the aquifer.

Sampling wastes would be generated during monitoring activities and should be managed in a manner that reduces contact with the environment. RI waste management practices could be continued to provide protection of human health and the environment during staging and disposal of these fluids.

Implementability

MNA is technically feasible and easily implemented. While an initial screening has already been performed, an RD phase is required to assess current site conditions and demonstrate effectiveness across the site. While MNA is reliable, screening and modeling can determine if MNA can reduce contaminants to RGs in a reasonable time. Data indicate contaminant reductions of over 98% in some wells since the RI.

No construction, operation, or maintenance issues are initially involved with this alternative; additional monitoring wells, if required, could be installed without difficulty. Current access controls — including military security and limited personnel access — have been reliable in the past. No administrative coordination would be required to implement the MNA alternative. MNA would not require offsite treatment services, materials, or innovative technologies.

Cost

Cost components for the MNA alternative include the following.

- Initial MNA assessment
- Fate-and-transport modeling
- Groundwater sampling and analysis
- Engineering, institutional controls, and report compilation

Costs associated with MNA are detailed in Section 3.5.2. Capital costs for Alternative G2 initial screening and startup — including direct, indirect and incidentals — are approximately \$278,000. Annual operating and maintenance costs for MNA long-term monitoring are \$51,000 per year.

Assuming a 6% discount rate over 30 years, the total present value for Alternative G2 is \$1.1 million.

Modifying Criteria

State/Support Agency Acceptance

FDEP and the USEPA are involved in a partnering team process with the Navy and will both have the opportunity to review and comment.

Community Acceptance

Community acceptance for Alternative G2 would be established after the public-comment period. Education of the public on the difference between MNA and no action might be required, if MNA is selected as the remedial alternative. This criterion is generally not completed until after public comments on the RI/FS report and the proposed plan are received.

3.5.3 Alternative G3: Enhanced Bioremediation

Under this alternative, contaminated groundwater is left in place but bioremediation is stimulated through engineered bioenhancement. In this alternative, molasses or a similar sugar substrate would be injected into the aquifer to drive oxidation/reduction conditions within the aquifer into the sulfate-reducing or methanogenic range, thus facilitating the degradation of lower oxidation state organics such as 1,2-DCE and VC. This alternative includes additional groundwater sampling, pilot testing, design and construction of the enhanced bioremediation system. A long-term groundwater monitoring program would be implemented in conjunction with the O&M program to assess the progress of the enhanced bioremediation system and to ensure that human health is protected. Institutional controls would be implemented with land-use restrictions that limit land to industrial use, and restrict groundwater use beneath and downgradient of the site.

Threshold Criteria

Overall Protection of Human Health and the Environment

Under an industrial scenario, enhanced bioremediation addresses the long-term effectiveness and permanence criterion by actively enhancing biological degradation of site contaminants. Protection of human health is accomplished by restrictions on groundwater use while contaminants exceed RGs. No short-term impacts would be associated with this alternative. This alternative would comply with chemical-specific ARARs once remediation is complete.

As previously discussed, no threats to Pensacola Bay have been identified. Protection of the environment and Pensacola Bay could be further monitored during this alternative.

Compliance with ARARs

This alternative is intended to comply with the chemical-specific groundwater ARARs. Bioenhancement is expected to accelerate degradation processes onsite; modeling and groundwater sampling is intended to document degradation of contaminants over time. FAC 62-777 is TBC for Site 38.

No location-specific ARARs would be triggered by Alternative G3. Injection permits would be required for the bioenhancement system.

Balancing Criteria

Long-Term Effectiveness and Permanence

The enhanced bioremediation alternative eliminates residual risk to site workers by: enhancing biodegradation processes within the aquifer, managing Site 38 as an industrial area, and preventing groundwater from being used as a potable source through institutional controls. MNA data indicate the aquifer is currently supporting biological degradation; enhancement, if required, is a feasible and effective option which would provide long-term, permanent aquifer remediation. The need for enhancement, as well as the actual system design, would be developed during RD using data from all site wells. The consumption of contaminated groundwater would be controlled

institutionally (through the LUCAP) and groundwater would be monitored until remedial goals are met.

Any controls currently in place onsite — including military security and limited access to the site — would remain. These controls are considered reliable for protecting human health, given the current and projected land use onsite.

Reduction of Toxicity, Mobility, or Volume Through Treatment

Enhanced bioremediation actively reduces the volume and toxicity of impacted groundwater through engineered biological processes.⁸ Biological degradation is considered irreversible. Contaminated groundwater would migrate according to current transport dynamics.

Short-Term Effectiveness

No implementation concerns are associated with enhanced bioremediation. The community is protected through groundwater restrictions and institutional controls. This alternative could be executed as soon as land-use restrictions and groundwater restrictions are in place. No implementation risks are associated with Alternative G3.

Workers exposed to risks should be trained according to Occupational Safety and Health Administration (OSHA) standards as required by 29 Code of Federal Regulations (CFR) 1910.120 to protect and mitigate risks during remedial construction. Field personnel contact with site contaminants would be minimal during construction (pump installation, control panel installation, and sanitary sewer connections). Workers could be protected by wearing appropriate personal protective equipment (PPE). Aquifer amendments are expected to include molasses and possibly ammonium nitrate, thus no chemical risks are posed to site workers.

⁸At some sites toxicity may be increased due to degradation of contaminants to more toxic forms, such as the transformation of TCE to VC, but current data do not indicate the accumulation of VC in the aquifer.

Sampling wastes would be generated during monitoring activities and should be managed in a manner that reduces contact with the environment. RI waste management practices could be continued to provide protection of human health and the environment during staging and disposal of these fluids.

Implementability

Enhanced bioremediation is technically feasible and easily implemented. MNA data already indicate contaminant reductions of over 98% in some wells since the RI; bioenhancement is expected to accelerate degradation rates.

Construction of an injection well network and developing an O&M system is easily implemented; additional monitoring wells, if required, could be installed without difficulty. O&M can be performed by the Navy or an outside contractor. Current access controls — including military security and limited personnel access — required for this alternative. Amendments for the system (molasses, ammonium nitrate, etc.), are easily obtained.

Cost

Cost components for the bioenhancement alternative include the following.

- Remedial design
- Pilot study
- Development and implementation of a monitoring program
- Installation and startup
- Institutional controls

Costs associated with enhanced bioremediation are detailed in Section 3.5.3. Capital costs for Alternative G3 initial screening and startup — including direct, indirect and incidentals — are approximately \$501,000. Annual operating and maintenance costs for enhanced bioremediation

are \$94,000 per year. Assuming a 6% discount rate over 30 years, the total present value for Alternative G3 is \$1.8 million.

Modifying Criteria

State/Support Agency Acceptance

FDEP and the USEPA are involved in a partnering team process with the Navy and will both have the opportunity to review and comment on this FS.

Community Acceptance

Community acceptance for Alternative G3 would be established after the public-comment period for the FS. This criterion is generally not completed until after public comments on the RI/FS report and the proposed plan are received.

3.5.4 Alternative G4: Groundwater Extraction and Disposal to FOTW

This alternative involves recovering groundwater by well extraction, then discharging it to the FOTW. Mass removal from the shallow aquifer in Site 38 would protect downgradient receptors. Alternative G4 would contain both areas of concern using two proposed recovery wells: one in the Building 604 area and one in the Building 71 area (Figure 3-13). Institutional controls would also be implemented at Site 38 for this alternative.

Threshold Criteria

Overall Protection of Human Health and the Environment

Human health is protected by containing groundwater that exceeds RG, thus preventing contaminant migration beyond the source area, and removing mass in contaminated zones.

In this alternative, extracted groundwater would be discharged directly to the FOTW without pretreatment. Human health and the environment would be protected through the FOTW's NPDES permit. If pretreatment was required, then this alternative is not feasible and alternative G4a would need to be implemented.

Compliance with ARARs

Groundwater extraction and treatment complies with the chemical-specific ARARs. The contaminated groundwater would be captured by extraction wells, thereby removing groundwater in which contaminants exceed RG. Removal of groundwater from Site 38 is intended to reduce the mass of contaminants in the aquifer and contain the groundwater areas of concern. Action-specific ARARs may include pretreatment and discharge requirements for waste water as outlined in the *Florida Industrial Waste Water Facilities* (Chapter 62-660), *Florida Water Quality Based Effluent Limitations* (Chapter 62-650), *Florida Pretreatment Requirements for Existing and New Sources of Pollution* (Chapter 62-625), and *Florida Waste Water Facility Permitting* (Chapter 62-620).

The FOTW is subject to NPDES requirements and FOTW effluent discharges must meet permit requirements.

Balancing Criteria

Long-Term Effectiveness and Permanence

Groundwater extraction would contain contaminants and reduce groundwater contamination by mass removal. Groundwater migration is expected to be arrested by the containment system. Alternative G4 reduces risk through mass removal and offers protection by containing the source. Furthermore, groundwater monitoring effectively assesses mass reduction and contaminant migration potential from areas not contained by groundwater extraction.

For the purpose of the FS, the projected remedial time frame is five years. Risks to human health and the environment onsite are expected to decrease with time as constituents are removed.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative is a mass removal/containment alternative. Groundwater removal at Site 38 would reduce groundwater toxicity and contaminant volume. Groundwater containment eliminates contaminant migration. This alternative also reduces mobility or volume through mass removal.

Assuming no requirement for pretreatment, this water would be collected and discharged to the FOTW. Mass removal of chlorinated solvents and primary metals from the surficial aquifer is expected to be permanent.

Short-Term Effectiveness

Adverse impacts to the surrounding environment are not anticipated during groundwater recovery system construction. Approval to discharge to the FOTW needs to be obtained before implementation. After design plans are approved and testing is complete, the groundwater collection system would be constructed. Collection of five pore volumes is estimated to take five years.

Workers exposed to risks should be trained according to OSHA standards as required by 29 CFR 1910.120 to protect and mitigate risks during remedial construction. Field personnel contact with site contaminants would be minimal during construction (pump installation, control panel installation, and sanitary sewer connections). Workers could be protected by wearing appropriate PPE. Compliance with RGs can be determined by monitoring site wells. System performance and mass removal can be evaluated by effluent monitoring. Alternative G4 would be compatible with any additional remedial actions, if required.

Implementability

Extraction of contaminated groundwater from below the site is both technically and administratively feasible. This alternative would not require any extraordinary services, materials, specialists, or innovative technologies. Construction and operation could be achieved with minimal difficulty.

Cost

Direct and indirect costs associated with groundwater extraction Alternative G4 are \$263,000. Annual operation, maintenance, monitoring, and FOTW costs are expected to be \$380,000 (including groundwater monitoring); the bulk of this annual cost is for disposal to the FOTW at

\$4.56 per 1,000 gallons totaling \$300,000 per year. The total present value cost of Alternative G4, including implementing institutional controls and the costs for the corrective action contractor, is estimated to be \$1,864,000 (assuming a 6% discount rate over five years).

Modifying Criteria

State/Support Agency Acceptance

FDEP and the USEPA are involved in the partnering team process with the Navy and will both have the opportunity to review and comment.

Community Acceptance

These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

3.5.5 Alternative G4a: Groundwater Extraction and Air Stripping with Inorganics Pretreatment

This alternative involves recovering groundwater by well extraction. Extracted groundwater is then treated onsite and discharged to the FOTW. The treatment technologies identified for groundwater are chemical/physical processes for chlorinated hydrocarbons and primary and secondary heavy metals. Area remediation would remove a potential source of downgradient contamination, and permit natural flushing and attenuation of contaminated plumes. Due to site complications (i.e., multiple contaminant types, brackish water quality, and saline intrusion), the most practicable treatment train was coagulation and precipitation followed by air stripping. This alternative also includes institutional controls.

Threshold Criteria

Overall Protection of Human Health and the Environment

Human health is protected by extracting, containing, and treating groundwater in which contaminants exceed RGs for VOCs and inorganics, thus preventing contaminant migration beyond the source area and effecting mass removal in contaminated zones. Extracted groundwater would be treated before discharge to the FOTW. Institutional controls would limit groundwater use.

Compliance with ARARs

Groundwater extraction and treatment complies with the chemical-specific ARARs. The contaminated groundwater would be captured by extraction wells and treated, thus removing compounds that exceed RGs. Groundwater removal from Site 38 is intended to reduce the mass of contaminants in the aquifer and contain the two groundwater areas of concern.

Waste disposal standards for waste generated from the treatment system would be triggered; specific waste disposal ARARs depend on sludge characteristics. Both federal and Florida action-specific ARARs would be met by Alternative G4a. Hazardous materials may be treated or stored onsite as a result of remedial activity and proper management of these materials in accordance with Florida Hazardous Waste Rules would be required. Location- and action-specific ARARs include the following:

- Floodplain requirements as outlined in the *National Environmental Policy Act* (40 CFR Part 6, Appendix A).
- Treatment residuals requirements as outlined in the *RCRA Identification of Hazardous Waste* (40 CFR 261), *RCRA Generator Standards* (40 CFR 262), *RCRA Facility Standards* (40 CFR 264), *RCRA Land Disposal Restrictions* (40 CFR 268), *DOT Rules for the*

Transport of Hazardous Substances (49 CFR Parts 107 and 171-179), and *Florida Hazardous Waste Rules* (Chapter 62-730).

- Requirements for air emissions as outlined in the *Clean Air Act Permits Regulation* (40 CFR 72) and *Florida Air Pollution Rules* (Chapters 62-210, 62-212, 62-213, and 62-296).
- Discharge and pretreatment requirements as outlined in the *Clean Water Act General Pretreatment regulations for Existing and New Sources of Pollution* (40 CFR 403), *Florida Industrial Waste Water Facilities* (Chapter 62-660), *Florida Water Quality Based Effluent Limitations* (Chapter 62-650), *Florida Pretreatment Requirements for Existing and New Sources of Pollution* (Chapter 62-625), *Florida Waste Water Facility Permitting* (Chapter 62-620).

The FOTW is subject to NPDES requirements and all FOTW effluent must meet these requirements.

Balancing Criteria

Long-Term Effectiveness and Permanence

Groundwater extraction and treatment would contain contaminants and reduce VOC and inorganic concentrations through mass removal. Groundwater migration is expected to be arrested by the containment system. Groundwater extraction removes contaminants from the surficial zone and contains plume areas and effectively removes contaminant mass. Ex situ groundwater treatment removes contaminants from the aqueous phase. Groundwater monitoring effectively assesses mass reduction and contaminant migration potential from areas not contained by groundwater extraction.

Reduction of Toxicity, Mobility, or Volume Through Treatment

This alternative removes and contains mass. Groundwater removal at Site 38 would reduce its toxicity and contaminant volume.

Air stripping and the proposed chemical and physical treatment units are established technologies for removing contaminants. Inorganic compounds (primary and secondary metals) would be separated in a sludge or concentrated liquid and disposed of offsite. Groundwater containment eliminates contaminant migration. This alternative reduces toxicity, mobility, or volume through treatment, and satisfies the statutory preference for treatment as a principal element. However, contaminants are not destroyed: the vapor stream will be discharged to the atmosphere and the pretreatment process residuals will require offsite disposal.

Short-Term Effectiveness

Adverse impacts to the surrounding environment are not anticipated during groundwater recovery and treatment system construction. The FOTW needs to accept discharge before implementation. After design plans are approved and testing is complete, the groundwater collection system would be constructed. Collection of five pore volumes is estimated to take five years.

Field personnel contact with site contaminants would be minimal during construction (pump installation, control panel installation, and sanitary sewer connections). Workers exposed to risks should be trained according to OSHA standards as required by 29 CFR 1910.120 to protect and mitigate risks during remedial construction. Field personnel contact with site contaminants would be minimal during construction (pump installation, control panel installation, and sanitary sewer connections). Workers could be protected by wearing appropriate PPE.

Compliance with RGs can be determined by monitoring site wells. System performance and mass removal can be evaluated by effluent monitoring. Alternative G4 would be compatible with any additional remedial actions required.

Implementability

Extracting contaminated groundwater from beneath the site and providing treatment is both technically and administratively feasible. This alternative would not require any extraordinary services, materials, specialists, or innovative technologies. Construction and operation could be achieved with minimal difficulty. Offsite disposal would be required for solids or concentrated liquids generated by the treatment processes. Implementation could begin immediately.

Cost

Costs are discussed in two groups: (1) groundwater recovery and (2) groundwater treatment:

- *Alternative G4: Groundwater Recovery:* Direct and indirect costs associated with groundwater extraction for Alternative 4a are \$263,000 (includes institutional controls, aquifer testing, and FOTW cooperation). Annual operation and maintenance, monitoring, and disposal costs are expected to be \$380,000, of which \$300,000 is related to FOTW fees.
- *Alternative G4a: Air Stripping with Coagulation/Precipitation:* Direct and indirect capital costs for air stripping and physical/chemical treatment for Alternative G4a are \$1,001,000. Annual operating costs for treatment are expected to be \$178,000.

The total present value of air stripping with coagulation/precipitation is \$3,602,000 including groundwater recovery (assuming a 6% discount rate over five years).

Modifying Criteria

State/Support Agency Acceptance

FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance

These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

3.6 Comparative Analysis of Alternatives

The five groundwater remedial alternatives are comparatively analyzed based on the nine criteria, and summarized in Table 3-15.

Table 3-15
 Comparative Analysis of Groundwater Alternatives

Evaluation Criteria	Alternative G1	Alternative G2	Alternative G3	Alternative G4	Alternative G4a
Threshold Criteria					
Protection of human health and the environment (HH&E)	No action is implemented to protect HH&E. Without action, current conditions are not protective.	Restrictions on groundwater use and attenuation of contaminant concentrations will protect HH&E.	Protects HH&E by enhancing biodegradation of contaminants in the groundwater and restricting groundwater use.	Protects HH&E through groundwater containment and removal, and restricting groundwater use.	Protects HH&E through groundwater containment, removal, and treatment, and by restricting groundwater use.
Compliance with ARARs	Does not comply with ARARs.	Exceedances are monitored to ensure compliance over time.	Exceedances are monitored to ensure compliance over time.	Complies with ARARs through containment and mass removal.	Complies with ARARs through containment, mass removal, and treatment.
Balancing Criteria					
Long-term effectiveness and permanence	None.	Attenuation is a slow process, but significant reductions have already been documented since 1994. Treatment is permanent.	Enhanced bioremediation is expected to be effective given degradation already documented onsite. Treatment is permanent.	Groundwater contaminant migration is expected to be arrested by the containment system.	Groundwater contaminant migration is expected to be arrested by the containment system. Contaminants are removed from groundwater into the vapor phase or through precipitation. Treatment residuals will require management.
Reduction of toxicity, mobility, or volume through treatment	None.	Toxicity, mobility, and volume are reduced via natural processes.	Toxicity, mobility, and volume are reduced via enhanced degradation (treatment).	Reduces toxicity, mobility, and volume through mass removal.	Reduces toxicity, mobility, and volume through mass removal and treatment.

Table 3-15
Comparative Analysis of Groundwater Alternatives

Evaluation Criteria	Alternative G1	Alternative G2	Alternative G3	Alternative G4	Alternative G4a
Short-term effectiveness	No short-term risks are associated with no-action.	No short-term risks are associated with MNA.	Adverse impacts to surrounding environment are not anticipated during enhanced bioremediation system construction.	Adverse impacts to surrounding environment are not anticipated during groundwater recovery system construction.	Adverse impacts to surrounding environment are not anticipated during groundwater recovery system construction.
Implementability	Technically and administratively feasible. Easily implemented.	Technically and administratively feasible. Easily implemented.	Technically and administratively feasible. Requires routine system O&M.	Technically and administratively feasible. Requires routine system O&M.	Technically and administratively feasible. Requires routine system O&M. Offsite disposal of sludge required.
Cost	Capital: none Annual: \$56,000 (every five years) PW: \$137,000	Capital: \$272,000 Annual: \$51,000 PW: \$1,061,000	Capital: \$501,000 Annual: \$94,000 PW: \$1,795,000	Capital: \$263,000 Annual: \$380,000 PW: \$1,864,000	Capital: \$1,264,000 Annual: \$558,000 PW: \$3,602,000
Modifying Criteria					
State support and agency acceptance	FDEP and USEPA will have an opportunity to review and comment on this technology.	FDEP and USEPA will have an opportunity to review and comment on this technology.	FDEP and USEPA will have an opportunity to review and comment on this technology.	FDEP and USEPA will have an opportunity to review and comment on this technology.	FDEP and USEPA will have an opportunity to review and comment on this technology.

Table 3-15
Comparative Analysis of Groundwater Alternatives

Evaluation Criteria	Alternative G1	Alternative G2	Alternative G3	Alternative G4	Alternative G4a
Community acceptance	Community acceptance would be established after comment period.	Community acceptance will be determined after the public-comment period. Public education on the difference between no-action and MNA may be required.	Community acceptance would be established after comment period.	Community acceptance would be established after comment period.	Community acceptance would be established after comment period.

Notes:

Alternative G1 = No-action
 Alternative G2 = Monitored natural attenuation
 Alternative G3 = Enhanced bioremediation
 Alternative G4 = Groundwater extraction and disposal to the FOTW
 Alternative G5 = Groundwater extraction and air stripping with inorganics pretreatment
 PW = present worth

4.0 SOIL FEASIBILITY EVALUATION

As described in Section 2, soil concentrations have been compared to soil direct contact and leachability CTLs as promulgated in FAC 62-777 to determine the volume of soil impacted by former industrial operations at Site 38. Once exceedances were identified, they were evaluated to assess the likelihood of a widespread soil source area or persistent residual mass which could pose a risk to human health or the environment. These evaluations were used to develop the remedial approach to soil at Site 38, including remediation strategies.

4.1 Nature and Extent of Contamination

The nature and extent of soil contamination has been evaluated by comparing data to CTLs. Four sets of criteria were used to screen Site 38 soil:

- RSCTLs, protective of a residential land-use scenario
- ISCTLs, protective of an industrial land-use scenario
- SL-GW, soil leaching values protective of groundwater
- SL-SW, soil leaching values protective of marine surface water

Multiple sampling events were conducted at the Site 38 complex: all final soil data have been included in this soil screening. Only soil boring locations exceeding screening criteria are shown in the following sections.

4.1.1 Building 71

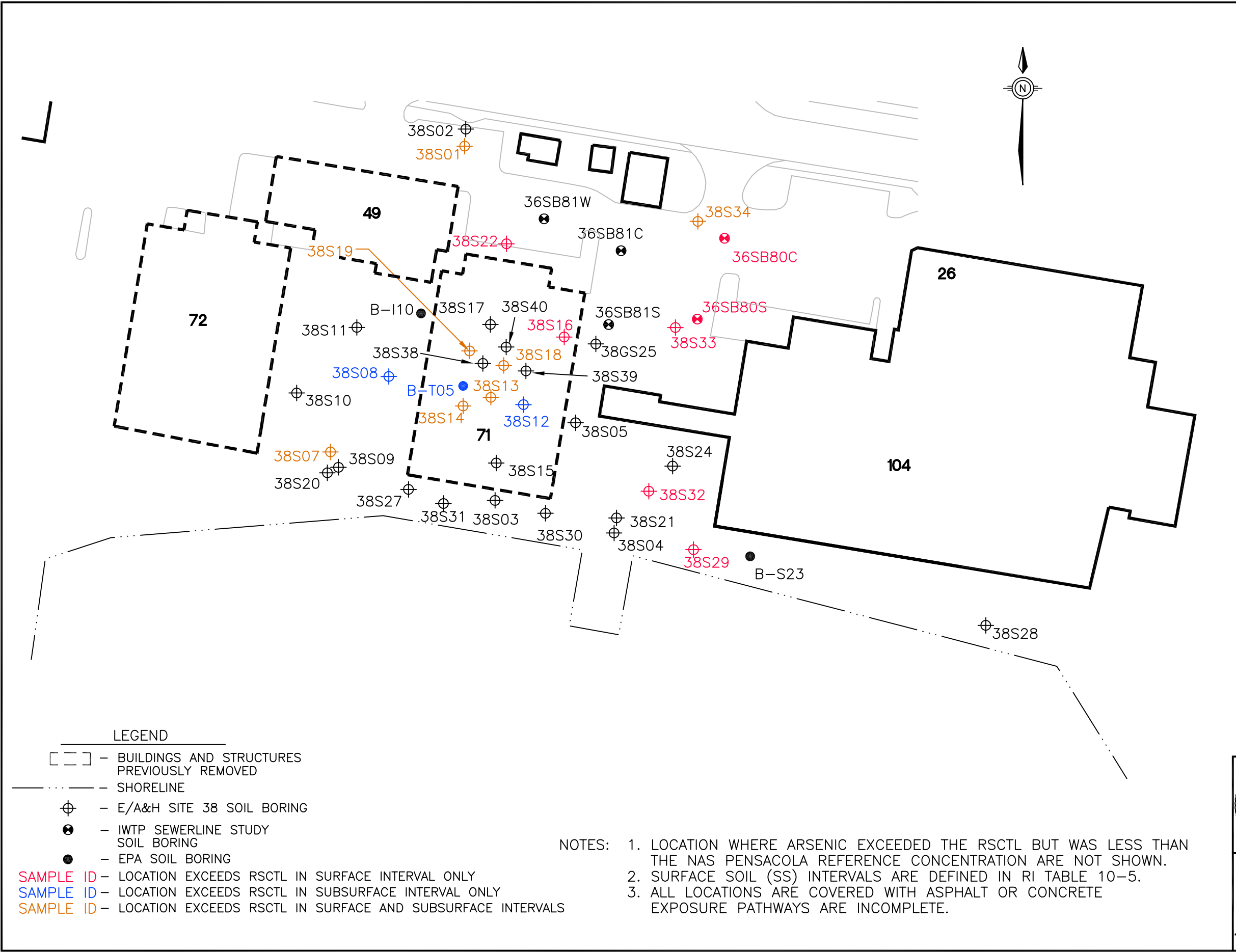
4.1.1.1 Building 71 Comparison with RSCTLs

Nineteen out of 35 locations exceeded one or more RSCTL, as shown in Table 4-1. Seven of these locations exceeded in the surface soil interval only, while nine exceeded for both surface and subsurface soil. Three locations exceeded RSCTLs in the subsurface only. Exceedances are shown on Figure 4-1.

Contaminants vary significantly from location to location, and include arsenic, chromium, copper, lead, vanadium, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, phenol, and Aroclor-1254.

Arsenic is ubiquitous across the site, ranging in concentration from below the NAS Pensacola RC of 1.56 mg/kg to a maximum of 15.6 mg/kg; only concentrations above the RC were evaluated during this screening. A total of 12 locations exceeded the RC for arsenic: 38S01 (-02), 38S07 (-01, -03), 38S12 (-03), 38S13 (-03, -04), 38S14 (-01, -03), 38S16 (-01), 38S19 (-01), 38S22 (-01), 38S32 (-01), and 38S34 (-01).¹ These locations are discontinuous across the site. For example, location 38S16, which exhibits contamination in the -01 interval, is bounded to the east and west by 38S40, 38S18, 38SB81S, and 38GS25, none of which exhibit arsenic contamination. Arsenic is not continuous in any interval across the site, as evidenced by 38S14, exhibiting contamination in the -01 interval, which is 20 feet southeast of 38S13 (which exhibits arsenic above its RC only in the -03 and -04 intervals) and 15 feet south of B-T05 (which does not exhibit arsenic contamination at all). Arsenic contamination above the RC, therefore, is sporadic and inconsistent with depth, indicating the absence of a significant source area. Below the Building 71 foundation, chromium is quantified above RSCTLs in 38S13, 38S14, and 38S18; the other seven borings completed through the foundation did not exhibit chromium concentrations above RSCTLs, again suggesting the absence of a significant chromium source area.

¹Most Site 38 locations are designated -01 for the 0- to 1-foot interval, -02 for the 1- to 2-foot interval, -03 for the 2- to 3- foot interval, etc. Therefore -01 designates a surface soil sample; all other intervals designate subsurface soil. The exceptions are as follows: 38S01, which uses -02 to designate the 0- to 2-foot interval, which is considered surface soil at this location. In addition, all Site 36 (IWTP) samples were collected on 2-foot intervals. Therefore, all Site 36 borings ending in -02 designate the 0- to 2-foot interval (surface soil), all borings ending in -04 designate the 2- to 4-foot interval, etc.)



INTERVAL	LOCATIONS EXCEEDING ONE OR MORE RSCTL
-01 (ALL SS)	38S13
	38S14
	38S16
	38S18
	38S19
	38S22
	38S29
	38S32
	38S33
	38S34
	38S35
	38S36
	38S37
	38S01 (SS)
-02	36S080C (SS)
	36S080S (SS)
	B-T05
-03	38S07
	38S08
	38S12
	38S13
	38S14
	38S18
	38S26
	38S37
	38S12
-04	38S13
	38S42
-05	38S18
	38S26
-06	38S01

70 0 70
SCALE FEET

SITE 38
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FIGURE 4-1
BUILDING 71
LOCATIONS EXCEEDING ONE OR MORE RSCTL

DWG DATE: 11/04/99 | DWG NAME: 0059G037

Table 4-1
Building 71 Compounds Detected above Residential SCTLs

Sample Id	Parameter	RSCTL	Result
RI Samples			
038S000102	Arsenic	0.8	1.6
	Vanadium	15	16.7
	Benzo(a)pyrene	100	200.0 J
038S000106	Arsenic	0.8	1.2 < Arsenic RC
	Benzo(a)pyrene	100	440.0 J
	Dibenz(a,h)anthracene	100	140.0 J
038S000301	Arsenic	0.8	1.2 < Arsenic RC
038S000701	Arsenic	0.8	2.4
038S000703	Arsenic	0.8	2.2
	Lead	400	425.0
038S000803	Benzo(a)pyrene	100	230.0 J
038S001203	Arsenic	0.8	1.7
	Copper	110	112.0
	Benzo(a)pyrene	100	410.0
	Dibenz(a,h)anthracene	100	160.0 J
038S001204	Arsenic	0.8	15.6
038S001301	Chromium	210	713.0
038S001303	Arsenic	0.8	3.7
	Chromium	210	553.0
038S001304	Arsenic	0.8	3.2
	Chromium	210	296.0
038S001401	Arsenic	0.8	1.9
	Chromium	210	665.0
	Copper	110	155.0
	Phenol	900	990.0

Table 4-1
 Building 71 Compounds Detected above Residential SCTLs

Sample Id	Parameter	RSCTL	Result
RI Samples			
038S001403	Arsenic	0.8	1.3 < Arsenic RC
	Chromium	210	331.0
	Copper	110	390.0
038S001601	Arsenic	0.8	2.2
	Vanadium	15	16.6
038S001701	Arsenic	0.8	1.0 < Arsenic RC
038S001801	Chromium	210	291.0
	Aroclor-1254	500	16,000.0 J
	Phenol	900	930.0 J
038S001803	Arsenic	0.8	1.2 < Arsenic RC
	Aroclor-1254	500	11,000.0 J
038S001805	Arsenic	0.8	1.1 < Arsenic RC
	Lead	400	491.0
	Aroclor-1254	500	8,000.0 J
038S001901	Arsenic	0.8	1.9
038S001902	Arsenic	0.8	0.8 < Arsenic RC
038S002201	Arsenic	0.8	1.6
038S002901	Arsenic	0.8	1.0 < Arsenic RC
	Benzo(a)pyrene	100	200.0 J
	Dibenz(a,h)anthracene	100	180.0 J
038S003201	Arsenic	0.8	3.0
	Copper	110	131.0
	Arsenic	0.8	3.9
	Benzo(a)pyrene	100	690.0 J
	Dibenz(a,h)anthracene	100	230.0 J
038S003301	Vanadium	15	31.7

Table 4-1
Building 71 Compounds Detected above Residential SCTLs

Sample Id	Parameter	RSCTL	Result	
RI Samples				
038S003401	Arsenic	0.8	2.4	
	Vanadium	15	33.4	
	Benzo(a)pyrene	100	150.0	J
038S003403	Benzo(b)fluoranthene	1400	2,100.0	J
	Dibenz(a,h)anthracene	100	590.0	J
USEPA Samples				
038S0T0502	Benzo(a)pyrene	100	380.0	J
IWTP Sewer Investigation Samples				
036S080C02	Arsenic	0.8	1.3	J
036S080S02	Copper	110	5,340.0	
Chromium Data				
038S013B02	Chromium	210	383.0	J

Notes:

RSCTLs may be found in Appendix F.

J = Concentration is estimated.

All inorganic compounds are in mg/kg (milligrams per kilogram)

All organic compounds are in µg/kg (micrograms per kilogram).

PCBs were identified in boring 38S18 in the -01, -03, and -05 intervals, but surrounding borings did not quantify PCBs above RSCTLs, indicating there is no significant PCB source area.

PAHs were quantified in 38S01 (-02 and -06 interval), 38S08 (-03 interval), 38S12 (-03 interval), 38S29 (-01 interval), 38S32 (-01 interval), 38S33 (-01 interval), 38S34 (-01 and -03 intervals), and B-T05 (-02 interval). However, these locations are widespread and do not indicate a lateral source of contamination as intervening borings are below RSCTLs for PAHs; notably, all of these

locations (except 38S12 and B-T05) are below asphalt pavement and may therefore exhibit PAH contamination due to normal leaching from the asphalt matrix.

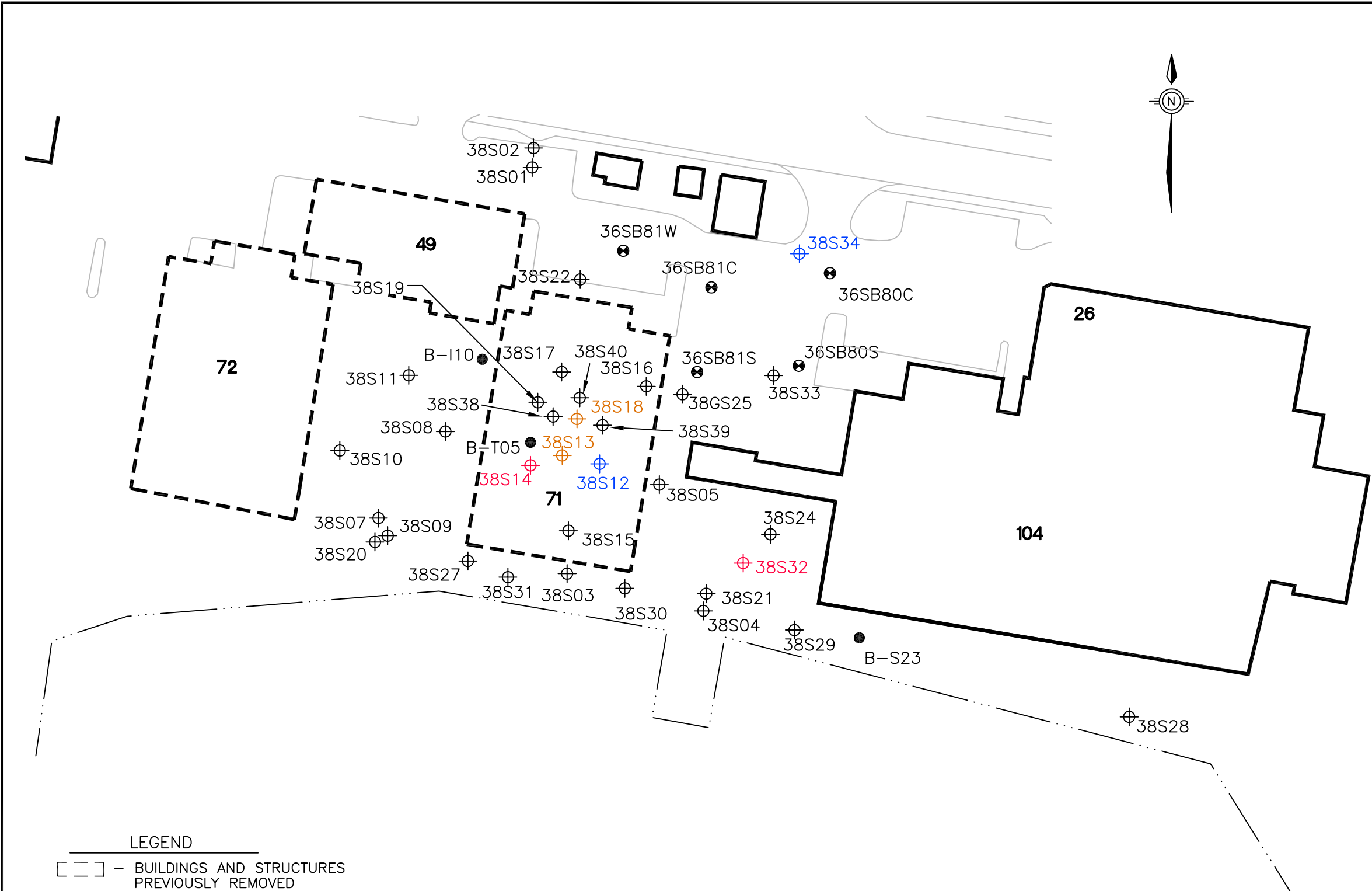
If the entire site is assumed contaminated to a depth of two feet, then the impacted area is approximately 330 feet by 290 feet. The impacted volume, then, is approximately 7,100 cubic yards (CY). Any excavation to depth to remove soil above RSCTLs would add to this volume. It is important to note that the entire Building 71 area is paved with either asphalt or concrete, and thus exposure pathways associated with residential use are not currently viable.

4.1.1.2 Building 71 Comparison with ISCTLs

Six locations out of 35 exceeded one or more ISCTLs, as shown in Table 4-2. Two locations exceeded only in the surface soil interval, 38S14 (for chromium) and 38S32 (for arsenic and benzo[a]pyrene). Two locations exceeded in surface and subsurface intervals (38S13 and 38S18 for chromium and PCBs, respectively). Two locations exceeded ISCTLs only in subsurface intervals, 38S12 (arsenic) and 38S34 (dibenz[a,h]anthracene). The locations are shown in Figure 4-2.

Surface soil exceedances are constrained to the center of former Building 71, and cover an area approximately 105 feet by 80 feet. Two isolated exceedances, 38S32 and 38S34, are each assumed to represent an area 20 feet in diameter. Assuming surface soil impacts (to a depth of 2 feet bgs), approximately 645 CY of soil exceed ISCTLs at this site. Any excavation to depth to remove soil above ISCTLs would add to this volume. It is important to note that the entire Building 71 area is paved with either asphalt or concrete, and thus exposure pathways associated with industrial use are not currently viable.

INTERVAL	LOCATIONS EXCEEDING ONE OR MORE ISCTL
-01 (ALL SS)	28S13
	38S14
	38S18
	38S32
-02	38S13
-03	38S18
	38S34
-04	38S12
-05	38S18



LEGEND

[---] - BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED

----- - SHORELINE

⊕ - E/A&H SITE 38 SOIL BORING

⊗ - IWTP SEWERLINE STUDY SOIL BORING

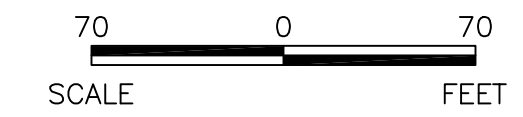
● - EPA SOIL BORING

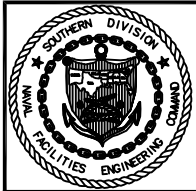
SAMPLE ID - LOCATION EXCEEDS ISCTL IN SURFACE INTERVAL ONLY

SAMPLE ID - LOCATION EXCEEDS ISCTL IN SUBSURFACE INTERVAL ONLY

SAMPLE ID - LOCATION EXCEEDS ISCTL IN SURFACE AND SUBSURFACE INTERVALS

NOTES: 1. SURFACE SOIL (SS) INTERVALS ARE DEFINED IN RI TABLE 10-5.
2. ALL LOCATIONS ARE COVERED WITH ASPHALT OR CONCRETE EXPOSURE PATHWAYS ARE INCOMPLETE.





SITE 38
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FIGURE 4-2
BUILDING 71
LOCATIONS EXCEEDING ONE OR MORE
ISCTL

DWG DATE: 11/04/99 | DWG NAME: 0059G038

Table 4-2
Building 71 Compounds Detected above Industrial SCTLs

Sample ID	Parameter	ISCTL	Result
RI Data			
038S001204	Arsenic	3.7	15.6
038S001301	Chromium	420	713.0
038S001303	Chromium	420	553.0
038S001401	Chromium	420	665.0
038S001801	Aroclor-1254	2100	16,000.0 J
038S001803	Aroclor-1254	2100	11,000.0 J
038S001805	Aroclor-1254	2100	8,000.0 J
038S003201	Arsenic	3.7	3.9
	Benzo(a)pyrene	500	690.0 J
038S003403	Dibenz(a,h)anthracene	500	590.0 J

Notes:

ISCTLs may be found in Appendix F.

J = Concentration is estimated.

All inorganic compounds are in mg/kg (milligrams per kilogram)

All organic compounds are in μ g/kg (micrograms per kilogram).

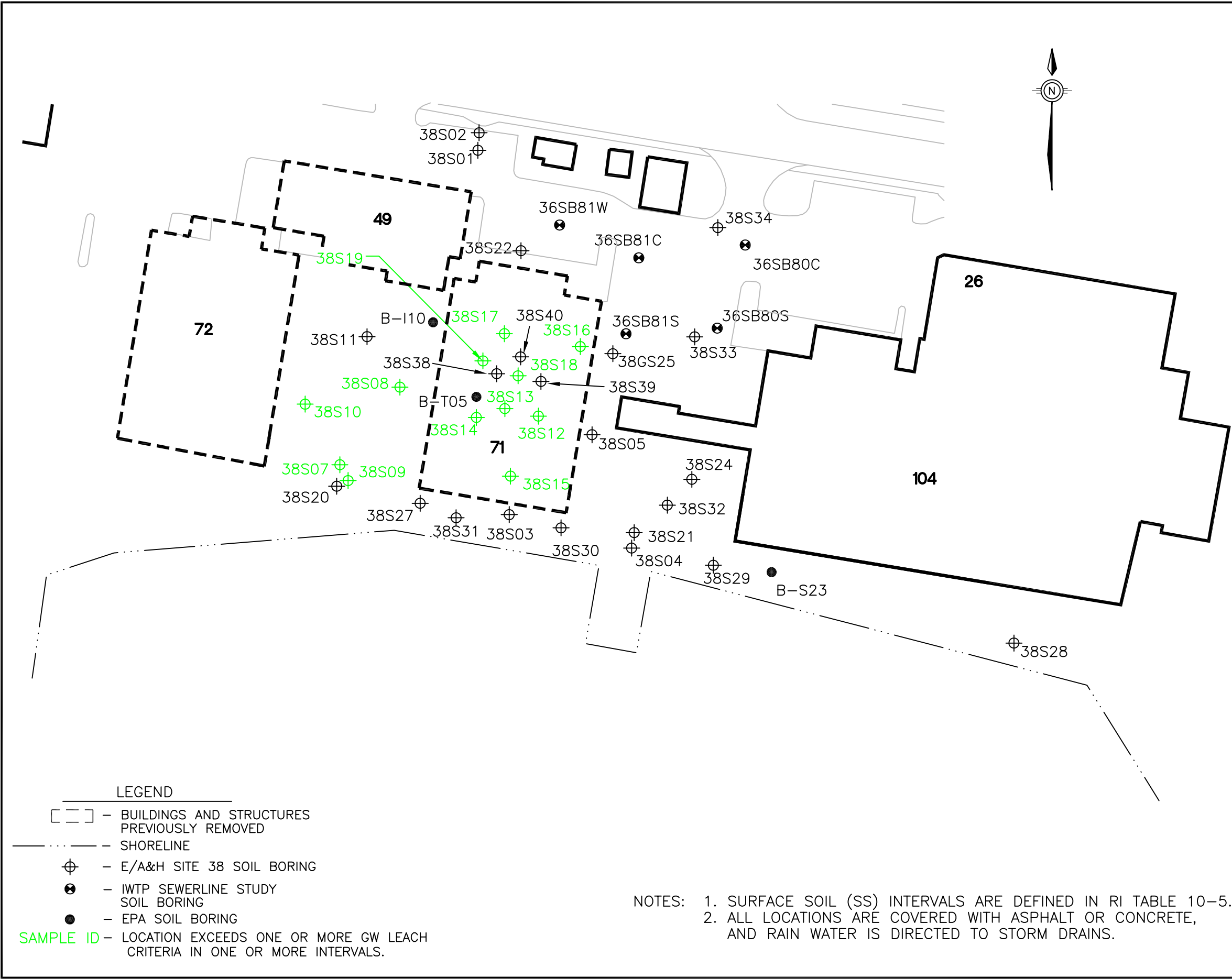
4.1.1.3 Building 71 Comparison with Leaching Values Protective of Groundwater

The leaching potential for site soil was evaluated using FDEP's soil leaching criteria protective of groundwater (SL-GW); exceedances are shown in Table 4-3 and on Figure 4-3. The primary exceedances detected in soil were cadmium, chromium, 2-methylphenol, 4-methylphenol, phenol, chloroform, 1,2-dichloroethane, tetrachloroethene (PCE), and trichloroethene (TCE). However, of these compounds, only cadmium, chromium, chloroform, PCE, and TCE were detected in Building 71 groundwater at concentrations above groundwater protection criteria. These data indicate that other contaminants in soil are not appreciably leaching to groundwater.

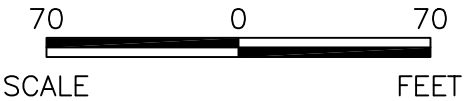
Cadmium was quantified in one boring, 38S14 (-01), at 18.6 mg/kg (roughly two times the SL-GW criterion). Wells I-10 (upgradient), 38GS05 (sidegradient), 38GS13 (downgradient) both exhibited cadmium concentrations above groundwater criteria, but all other Building 71 wells were below cadmium's groundwater criteria. It is important to recognize that the SCTL leaching concentration is based on a 0.5 acre source, therefore the SL-GW criterion of 9 mg/kg represents the concentration present across a 0.5-acre site which would pose a threat to groundwater. Boring 38S14 represents a much smaller area, as it was not detected in adjacent borings B-T05 or 38S13, nor was it detected in all intervals of 38S14. These data, therefore, indicate that the 38S14 exceedance is not a significant source area for cadmium.

Chromium was quantified above the SL-GW criterion in several locations, including 38S10 (-01 only), 38S13 (-01, -03, -04), 38S14 (-01, -03, -05), 38S16 (-03 only), 38S17 (-01 only), 38S18 (-01, -03, -05), and B-I10 (-01). The impacted area is relatively small, less than 0.5 acre.² Data suggest there is no widespread source of chromium in subsurface soil, as locations around and between these exceedances are below the SL-GW criteria (e.g., 38S18 is surrounded by 38S39, 38S38, and 38S40, none of which exceed). Moreover, chromium is not continuous through soil column (e.g., 38S10, 38S16, and 38S17, where the exceedance was only quantified in one interval and not the other two).

²As with cadmium, it is important to note that chromium's SL-GW criterion was estimated assuming a 0.5-acre source area. Because the Building 71 area is somewhat smaller, the allowable soil fraction would be higher than the published SL-GW criteria (all other assumptions being held constant). Also, the chromium leachability number was developed assuming hexavalent chromium was present within the subsurface. Given the sandy soil and the shallow nature of site contamination, it is unlikely that any chromium present in the soil column is in hexavalent form. Therefore use of the published SL-GW criteria for hexavalent chromium is not appropriate to Site 38 but is included in the text for discussion purposes only.



INTERVAL	LOCATIONS EXCEEDING ONE OR MORE GW LEACH CRITERIA
-01 (ALL SS)	38S07
	38S09
	38S10
	38S12
	38S13
	38S14
	38S15
	38S17
	38S18
	38S19
-02	B-I10
	38S19
	B-I10
-03	B-T05
	38S07
	38S08
	38S13
	38S14
	38S15
	38S16
	38S18
-04	38S13
-05	38S07
	38S14
	38S18



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PENSACOLA, FLORIDA

FIGURE 4-3
BUILDING 71
LOCATIONS EXCEEDING ONE OR MORE
GW LEACH CRITERIA

Table 4-3
Building 71 Compounds Detected above GW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-GW	Result
RI Data			
038S000701	Trichloroethene	30	110.0
038S000703	Trichloroethene	30	79.0
038S000705	Trichloroethene	30	74.0
038S000803	Trichloroethene	30	33.0
038S000901	Trichloroethene	30	36.0
038S001001	Chromium	38	103.0
	Tetrachloroethene	30	94.0
038S001201	Chromium	38	80.2
038S001301	Chromium	38	713.0
	Phenol	50	59.0 J
	Tetrachloroethene	30	43.0
	Trichloroethene	30	34.0
038S001303	Chromium	38	553.0
	Trichloroethene	30	120.0
038S001304	Chromium	38	296.0
	Trichloroethene	30	34.0
038S001401	Cadmium	8	18.6
	Chromium	38	665.0
	2-Methylphenol (o-Cresol)	300	340.0 J
	Phenol	50	990.0
	1,2-Dichloroethane	10	27.0 J
	Chloroform	30	47.0 J
	Tetrachloroethene	30	370.0
	Trichloroethene	30	390.0

Table 4-3
Building 71 Compounds Detected above GW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-GW	Result
038S001403	Chromium	38	331.0
	4-Methylphenol (p-Cresol)	30	580.0
	Phenol	50	830.0
	1,2-Dichloroethane	10	22.0
	Chloroform	30	79.0
	Tetrachloroethene	30	410.0 J
	Trichloroethene	30	400.0 J
038S001405	Chromium	38	155.0
	4-Methylphenol (p-Cresol)	30	190.0 J
	Phenol	50	180.0 J
	Tetrachloroethene	30	120.0
038S001501	Phenol	50	130.0 J
038S001503	Phenol	50	110.0 J
038S001603	Chromium	38	58.8
038S001701	Chromium	38	53.4
038S001801	Chromium	38	291.0
	Phenol	50	930.0 J
038S001803	Chromium	38	48.5
038S001805	Chromium	38	87.8
	Phenol	50	360.0 J
	Tetrachloroethene	30	230.0
	Trichloroethene	30	110.0
038S001901	Phenol	50	370.0 J
038S001902	Phenol	50	600.0 J
EPA Data			
038S011001	Chromium	38	93.0
038S011002	Tetrachloroethene	30	1,100.0 J

Table 4-3
Building 71 Compounds Detected above GW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-GW	Result
038S010502	Tetrachloroethene	30	810.0 J
	Trichloroethene	30	200.0
Chromium Data			
038S013A02	Chromium	38	40.1 J
038S013B02	Chromium	38	383.0 J

Notes:

SL-PQG may be found in Appendix F.

J = Concentration is estimated.

All inorganic compounds are in mg/kg (milligrams per kilogram)

All organic compounds are in $\mu\text{g/kg}$ (micrograms per kilogram).

To reevaluate the chromium contamination at Building 71, locations 38S13 and 38S14 were resampled in 1997 to evaluate potential leachability across the 3-foot unsaturated zone (See Appendix G). Data indicate wide variation in sample concentrations, suggesting significant aquifer heterogeneity and again indicating the absence of a widespread chromium source area. Only one of the three samples tested (sample 38S13B, 383 mg/kg total chromium) leached chromium above detection limits (0.16 mg/L in leachate). These data indicated minimal leaching was likely across the Building 71 area, where the majority of chromium detections was less than 38S13B's 383 mg/kg. During the RI, chromium was detected in Building 71 wells 38GS12 and 38GS13 at 326 micrograms per liter ($\mu\text{g/L}$) and 185 $\mu\text{g/L}$ respectively, but chromium concentrations in 38GS12 had decreased to below detectable levels by the 1998 sampling event. This event was performed using low-flow sampling techniques to minimize turbidity and suspended solids. 1998 data suggest chromium is not a concern in groundwater at Building 71.

Chloroform was detected in soil at one location, 38S14 (-01 only) above the SL-GW criterion. Chloroform did not exceed the SL-GW criterion in any other boring in the Building 71 area, and was not detected in deeper intervals in 38S14, suggesting there is no significant source mass for

chloroform in site soil. Two wells in the Building 71 area, 38GS11 (up- and sidegradient) and 38GS12 (sidegradient), detected chloroform above groundwater criteria; chloroform was not quantified above groundwater criteria in any downgradient wells. Therefore, data indicate chloroform at 38S14 does not pose threat to groundwater.

PCE was detected in a small subset of soil borings at Building 71, including 38S10 (-01 only), 38S13 (-01 only), 38S14 (-01, -03, and -05), 38S18 (-05 only), B-I10 (-02), and B-T05 (-02). PCE contamination at Building 71 is not widespread, as adjacent sample locations are below SL-GW criteria (e.g., 38S18 is surrounded by 38S39, 38S38, and 38S40, all of which are below SL-GW criteria). Moreover, contamination is not continuous through the soil column (e.g., 38S10 and 38S13 exhibit contamination only in the surface interval) and may be associated with groundwater at the deepest interval such as at 38S18, contaminated only at the -05 interval. PCE was only quantified in one well at Building 71, 38GS12, at 33 $\mu\text{g/L}$. PCE was not quantified in any downgradient wells. PCE's impact on the underlying aquifer appears limited, therefore PCE quantified in soil at Building 71 will not be considered a significant threat to groundwater.

TCE was quantified above SL-GW criteria in 38S07 (-01, -03, -05), 38S08 (-03), 38S09 (-01), 38S13 (-01, -03, and -04), 38S14 (-01, -03), 38S18 (-05), and B-T05 (-02). However, TCE contamination at Building 71 is not widespread, as adjacent locations are below the SL-GW criteria (e.g., location 38S18 is surrounded by 38S39, 38S38, and 38S40, all of which are below the SL-GW criteria). Nor is TCE contamination continuous through the soil column: locations 38S08 and 38S09 only quantified TCE in a single interval, and TCE may be associated with groundwater at the deepest interval (e.g., interval -05 at location 38S18). TCE was only quantified above groundwater criteria in GS-12 and GS-13, at 53 $\mu\text{g/L}$ and 4 $\mu\text{g/L}$ respectively. Wells 38GS05 and 38GS03, adjacent to borings 38S08, 38S07, and 38S09, show no impact above groundwater criteria. These data suggest limited spatial impact on the aquifer, if any. Consequently, TCE will not be considered a significant threat to groundwater at Building 71.

Compounds exceeding criteria included: mercury, benzo(a)pyrene, chrysene, fluoranthene, 4-methylphenol, pyrene, phenanthrene, phenol, Aroclor 1254, Aroclor 1260, gamma chlordane, 4,4'-DDE, endosulfan I, endosulfan II, endosulfan sulfate, endrin aldehyde, endrin ketone, 1,2-dichloroethane, and PCE. Of these compounds, only mercury, 4-methylphenol, phenanthrene, phenol, and PCE were detected in groundwater at Building 71, indicating that the remaining compounds were not leaching appreciably to groundwater.

Mercury is ubiquitous across the site, ranging in concentration from below the NAS Pensacola RC of 0.1 mg/kg to a maximum of 0.79 mg/kg; only concentrations above the RC were evaluated during this screening. The following locations exhibited mercury concentrations greater than 0.1 mg/kg: 38S04 (-02), 38S05 (-03), 38S12 (-01, -03), 38S13 (-03), 38S14 (-03), 38S17 (-05), 38S18 (-01,-05), 38S30 (-03), and 38S080S (-02). The areal extent of mercury contamination above SL-MSW is small and relatively discontinuous: contamination is present at 38S04/38S30, and then 38S12/38S13/38S14 (beneath Building 71's foundation) but not at intervening boring 38S15. Similarly, 38S18 is surrounded by 38S39, 38S38, 38S40, which do not exceed SL-MSW criteria. Mercury is not encountered continuously through the soil column (e.g., 38S04, 38S13,

4.1.1.4 Building 71 Comparison with Leaching Values Protective of Water Bodies

Twenty-four locations exceeded soil leaching values protective of marine surface water. Marine criteria were assessed because the Building 71 area abuts Pensacola Bay. Exceedances are identified in Table 4-4, and shown on Figure 4-4. 38S17). Mercury was only quantified in well GS-10, located sidegradient from the majority of borings exhibiting contamination. Wells directly downgradient of Building 71 did not exceed MSW criteria.

4-Methylphenol was quantified in one boring, 38S14 (-01 and -03 intervals). Neither of the adjacent borings (B-T05 or 38S13) quantified 4-methylphenol above SL-MSW criteria, thus it appears that there is no laterally continuous source in the subsurface. Additionally, 4-methylphenol was not detected at concentrations above SL-MSW criteria in the deepest interval at 38S14. 4-Methylphenol was detected in well GS-12 at concentrations below groundwater

criteria protective of marine surface water bodies. Therefore, concentrations of 4-methylphenol in soil at Building 71 will not be considered a threat to the environment.

Phenanthrene was detected in one location, B-T05 (-02), and in the groundwater monitoring well completed in the same borehole. The groundwater concentration, 3.7 $\mu\text{g/L}$, did not exceed any SCTLs. Therefore, because phenanthrene was not detected above SL-MSW criteria in any other boring or sample interval, and it was not detected at any downgradient monitoring well locations, it is not considered a threat to the environment.

Phenol was detected in several borings at Building 71, including 38S12 (-01), 38S13 (-01, -03), 38S14 (-01, -03, -05), 38S15 (-01, -03), 38S18 (-01, -05), and 38S19 (-01, -02). These borings are all located beneath the former Building 71's foundation. Contaminant distribution is fairly consistent in the upper (-01) interval, and is present in the subsurface in several locations. Phenol was detected in one groundwater monitoring well at Building 71, intermediate-depth well GI-02, at 9 $\mu\text{g/L}$; this concentration only slightly exceeds the groundwater criteria protective of marine water bodies (6.5 $\mu\text{g/L}$). Phenol was not detected in any shallow well, or any other intermediate well above groundwater criteria. Therefore, site data suggest phenol is not leaching appreciably to groundwater, and does not pose a threat to surface water.

PCE was quantified above SL-MSW criteria at locations 38S14 (-01, -03, and -05), 38S18 (-05 only), B-I10 (-02), and B-T05 (-02). These data indicate Building 71 soil is not widespread source for PCE contamination, as intervening/surrounding borings clean (e.g., contaminated boring 38S18 is surrounded by locations 38S39, 38S38, and 38S40, which do not exhibit PCE contamination). Nor is PCE continuous through the soil column (e.g., B-I10, B-T05); at 38S18, it is possible that PCE is associated with groundwater at the deepest interval (-05). PCE was quantified in 38GS12 at 33 $\mu\text{g/L}$, not in any other or downgradient wells. Because it has a limited spatial impact on the aquifer, data suggests PCE is not leaching appreciably to groundwater.

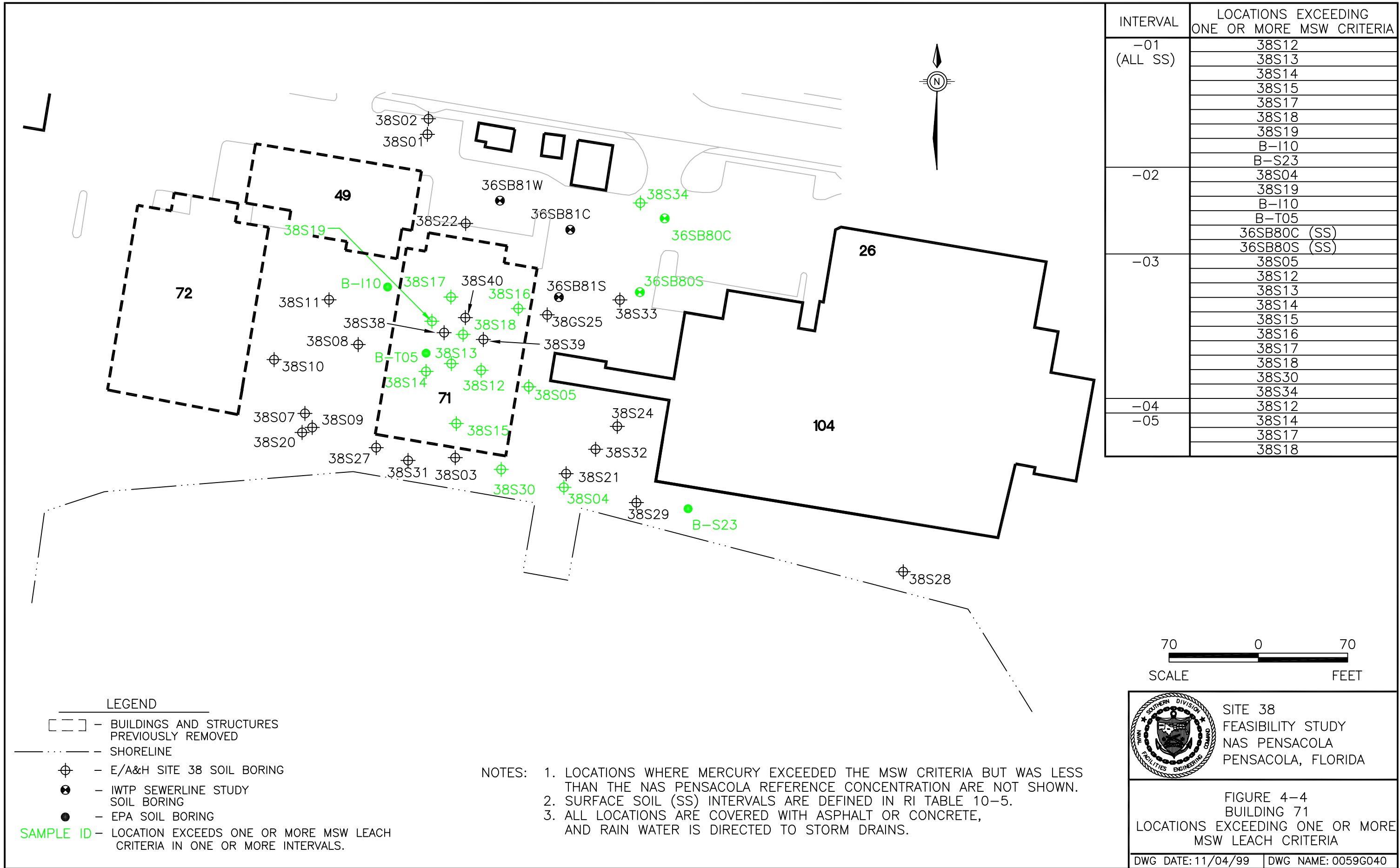


Table 4-4
Building 71 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result	Comment
RI Data				
038S000102	Mercury	0.01	0.04	< Mercury RC
038S000104	Mercury	0.01	0.06	< Mercury RC
038S000106	Mercury	0.01	0.06	< Mercury RC
038S000303	Mercury	0.01	0.04	< Mercury RC
038S000305	Mercury	0.01	0.03	< Mercury RC
038S000402	Mercury	0.01	0.12	
038S000404	Mercury	0.01	0.08	< Mercury RC
038S000501	Mercury	0.01	0.07	< Mercury RC
038S000503	Mercury	0.01	0.12	
038S000505	Mercury	0.01	0.05	< Mercury RC
038S000701	Mercury	0.01	0.05	< Mercury RC
038S000703	Mercury	0.01	0.05	< Mercury RC
038S000705	Mercury	0.01	0.04	< Mercury RC
038S000803	Mercury	0.01	0.07	< Mercury RC
038S000901	Mercury	0.01	0.05	< Mercury RC
038S001001	Mercury	0.01	0.10	< Mercury RC
038S001003	Mercury	0.01	0.06	< Mercury RC
038S001004	Mercury	0.01	0.03	< Mercury RC
038S001201	Mercury	0.01	0.12	
	Aroclor-1260	3	58.00	
	Phenol	30	39.00 J	
038S001203	Mercury	0.01	0.12	
038S001204	Mercury	0.01	0.07	< Mercury RC
038S001301	Mercury	0.01	0.05	< Mercury RC
	Aroclor-1260	3	55.00	
	Phenol	30	59.00 J	

Table 4-4
 Building 71 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result	Comment
038S001303	Mercury	0.01	0.20	
	Phenol	30	46.00 J	
038S001304	Mercury	0.01	0.10	< Mercury RC
038S001401	Mercury	0.01	0.07	< Mercury RC
	4-Methylphenol (p-Cresol)	500	740.00	
	Phenol	30	990.00	
	1,2-Dichloroethane	20	27.00 J	
	Tetrachloroethene	100	370.00	
038S001403	Mercury	0.01	0.20	
	4-Methylphenol (p-Cresol)	500	580.00	
	Phenol	30	830.00	
	1,2-Dichloroethane	20	22.00	
	Tetrachloroethene	100	410.00 J	
038S001405	Mercury	0.01	0.07	< Mercury RC
	Phenol	30	180.00 J	
	Tetrachloroethene	100	120.00	
038S001501	Mercury	0.01	0.03	< Mercury RC
	Phenol	30	130.00 J	
038S001503	Mercury	0.01	0.03	
	Phenol	30	110.00 J	
038S001601	Mercury	0.01	0.05	< Mercury RC
038S001603	Mercury	0.01	0.07	< Mercury RC
	Endosulfan II	0.8	5.80 J	
038S001605	Mercury	0.01	0.03 J	< Mercury RC
038S001701	Mercury	0.01	0.05	< Mercury RC
	Aroclor-1254	3	100.00	
	gamma-Chlordane	3	3.40 J	

Table 4-4
Building 71 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result	Comment
038S001703	Mercury	0.01	0.05	< Mercury RC
	Aroclor-1254	3	- 86.00 J	
	Endosulfan II	0.8	4.50 J	
038S001705	Mercury	0.01	0.15	
	Endosulfan II	0.8	4.60 J	
038S001801	Mercury	0.01	0.12	
	4,4'-DDE	100	900.00 J	
	Aroclor-1254	3	16,000.00 J	
	Endosulfan I	0.8	51.00 J	
	Endrin aldehyde	1	37.00 J	
	gamma-Chlordane	3	630.00 J	
	Phenol	30	930.00 J	
038S001803	Mercury	0.01	0.06	< Mercury RC
	4,4'-DDE	100	660.00	
	Aroclor-1254	3	11,000.00 J	
	Endosulfan I	0.8	61.00 J	
	gamma-Chlordane	3	410.00 J	
038S001805	Mercury	0.01	0.12	
	4,4'-DDE	100	480.00	
	Aroclor-1254	3	8,000.00 J	
	Endosulfan I	0.8	34.00 J	
	Endosulfan II	0.8	18.00 J	
	gamma-Chlordane	3	270.00 J	
	Phenol	30	360.00 J	
	Tetrachloroethene	100	230.00	

Table 4-4
Building 71 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result	Comment
038S001901	Mercury	0.01	0.06	< Mercury RC
	Phenol	30	370.00 J	
038S001902	Mercury	0.01	0.05	< Mercury RC
	Phenol	30	600.00 J	
038S002203	Mercury	0.01	0.03	< Mercury RC
038S003003	Mercury	0.01	0.41	
	Endosulfan sulfate	0.8	3.40	
038S003403	Aroclor-1260	3	49.00 J	
	Endrin ketone	1	14.00 J	
	Chrysene	700	1,800.00	
	Fluoranthene	1300	3,200.00	
	Pyrene	1300	2,900.00	
EPA Data				
038S011001	Aroclor-1254	3	90.00 J	
038S011002	Tetrachloroethene	100	1,100.00 J	
038S0S2301	Aroclor-1254	3	81.00 J	
038S0S2302	Mercury	0.01	0.09	< Mercury RC
038S0T0502	Acenaphthene	700	1,400.00 J	
	Anthracene	700	2,000.00 J	
	Benzo(a)anthracene	700	740.00 J	
	Chrysene	700	1,100.00 J	
	Fluoranthene	1300	1,700.00 J	
	Phenanthrene	700	17,000.00	
	Pyrene	1300	1,800.00 J	
	Tetrachloroethene	100	810.00 J	

Table 4-4
Building 71 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result	Comment
IWTP Data				
036S080C02	Aroclor-1260		25.00 J	
036S080S02	Mercury		0.79	

Notes:

SL-SW may be found in Appendix F.

J = Concentration is estimated.

D = Concentration was obtained from a diluted sample.

All inorganic compounds are in mg/kg (milligrams per kilogram)

All organic compounds are in µg/kg (micrograms per kilogram).

4.1.2 Building 604

4.1.2.1 Building 604 Comparison with RSCTLs

Thirty-six out of 64 locations exceeded one or more RSCTL, as shown in Table 4-5. Of these, 28 locations exceeded solely in the surface soil interval, while seven exceeded for surface and subsurface soil. One location exceeded RSCTLs in the subsurface only. Exceedances are shown on Figure 4-5. Contaminants vary significantly from location to location, and include arsenic, copper, iron, lead, vanadium, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-cd)pyrene, Aroclor-1254, and Aroclor-1260.

Arsenic is ubiquitous across the Building 604 area, ranging in concentration from below the NAS Pensacola RC of 1.56 mg/kg to a maximum of 21.1 mg/kg; only concentrations above the RC were evaluated during this screening. Copper and vanadium were the second and third most ubiquitous contaminants at Building 604. Contaminant locations and surface conditions are described in Table 4-6.

Lead was detected in only four locations, all of which are below pavement: 38S26 (-05 interval), 36SB74N (-02 interval), 36SB74W (-02 interval), and 36SB75E (-02 interval). Iron was detected

at 32,900 mg/kg in 36SB75E at the -06 interval. Of the inorganics, it is important to note that no contaminant is present consistently in every boring, and contaminants are not present at all depths: these data suggest that inorganic contamination is not representative of a source area.

PCBs were detected in B-T01 (-01 interval) and 38S37 (-01 interval), but were not quantified above RSCTLs in any other boring. These locations are isolated in a grassy area at the southeast corner of Building 604. Various PAHs were detected in several borings, primarily beneath asphalt pavement. Of locations exceeding RSCTLs for various PAHs, only 38S37 (-01 interval) is in a grassy, exposed area.

If paved and grassy areas are assumed contaminated to a depth of two feet, then the area exceeding RSCTLs at Building 604 (excluding Building 604 and areas south of South Avenue) is estimated to be 179,000 square feet (4.1 acres), 90% of which is paved with asphalt or concrete. Assuming contamination to a depth of two feet, the impacted volume, then, is approximately 13,200 CY. Any excavation to depths greater than 2 feet to remove soil above RSCTLs would add to this volume. Because so much of the site is paved with either asphalt or concrete, exposure pathways associated with residential use are not currently viable.

4.1.2.2 Building 604 Comparison with ISCTLs

Fifteen locations out of 64 exceeded one or more ISCTLs, as shown in Table 4-7. Eleven locations exceeded only in the surface soil interval, one exceeds in the surface and subsurface interval, and two locations exceed only in the subsurface. All exceedances are for arsenic, except 38S27 (-01) 36SB74C (-04), and 36SB77W (-02) which exceed for PAHs, and 36SB74N (-02), which exceeds the ISCTLs for arsenic and lead. The locations are shown in Figure 4-6.

Exceedances are widespread, and surrounding borings do not exhibit similar contaminant trends (e.g., 36SB74C is surrounded by 38S26, 36SB73C, B-T19, and 36SB74W, none of which exceed

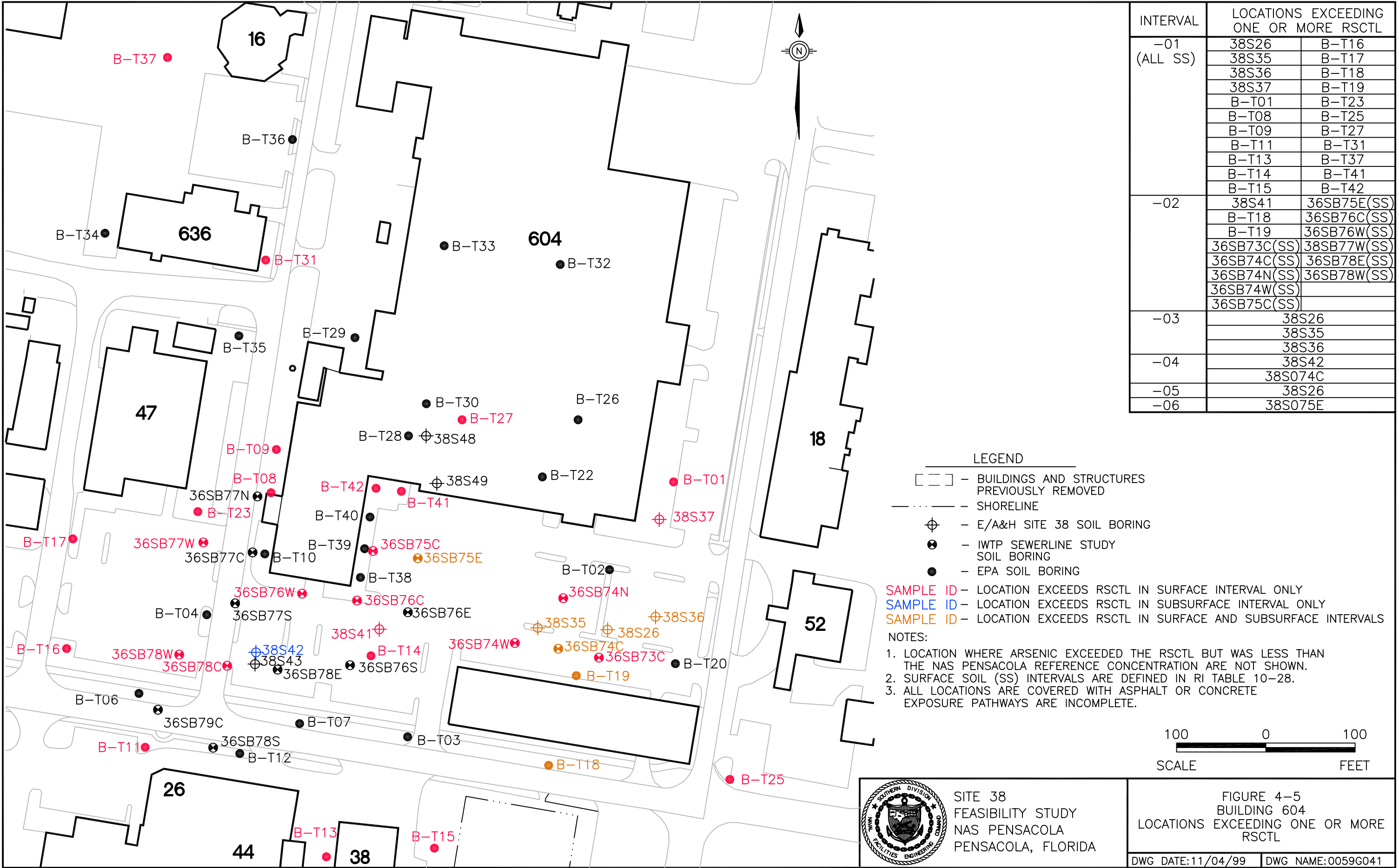


Table 4-5
Building 604 Compounds Detected above Residential SCTLs

Sample ID	Parameter	RSC TL	Result	Comment
RI Data				
038S002601	Arsenic	0.8	4.2	
	Vanadium	15	16.3	
	Benzo(a)pyrene	100	160.0 J	
038S002603	Arsenic	0.8	3.1	
	Copper	110	177.0	
	Benzo(a)pyrene	100	300.0 J	
038S002605	Arsenic	0.8	7.5	
	Lead	400	897.0	
	Benzo(a)pyrene	100	260.0 J	
038S003501	Arsenic	0.8	21.1	
	Vanadium	15	18.0	
	Benzo(a)pyrene	100	380.0 J	
038S003503	Arsenic	0.8	3.5	
038S003601	Arsenic	0.8	7.2	
	Vanadium	15	39.8	
038S003603	Arsenic	0.8	8.2	
038S003701	Arsenic	0.8	3.7 J	
	Vanadium	15	26.2	
	Aroclor-1260	500	570.0 J	
	Benzo(a)pyrene	100	260.0 J	
038S003703	Arsenic	0.8	0.9	< Arsenic RC
038S004102	Arsenic	0.8	1.4	< Arsenic RC
	Copper	110	308.0	
038S004202	Arsenic	0.8	0.9	< Arsenic RC
038S004204	Arsenic	0.8	1.2	< Arsenic RC
	Benzo(a)pyrene	100	190.0 J	

Table 4-5
 Building 604 Compounds Detected above Residential SCTLs

Sample ID	Parameter	RSCTL	Result	Comment
USEPA Data				
038S0T0101	Arsenic	0.8	5.1	
	Vanadium	15	29.0	
	Aroclor-1254	500	810.0	
038S0T0801	Vanadium	15	23.0	
038S0T0901	Vanadium	15	34.0	
038S0T1101	Arsenic	0.8	4.0	
	Copper	110	140.0	
038S0T1301	Vanadium	15	21.0	
038S0T1401	Arsenic	0.8	8.7	
	Vanadium	15	55.0	
038S0T1501	Arsenic	0.8	5.7	
038S0T1601	Arsenic	0.8	5.6	
	Vanadium	15	16.0	
038S0T1701	Arsenic	0.8	6.3	
038S0T1801	Vanadium	15	19.0	
038S0T1802	Arsenic	0.8	3.4	
038S0T1901	Vanadium	15	52.0	
038S0T1902	Arsenic	0.8	1.9	
038S0T2301	Arsenic	0.8	3.2	
038S0T2501	Arsenic	0.8	3.1	
038S0T2701	Benzo(a)anthracene	1400	2,600.0 J	
	Benzo(a)pyrene	100	2,200.0 J	
	Benzo(b)fluoranthene	1400	3,800.0	
038S0T3101	Copper	110	140.0	
038S0T3701	Dieldrin	70	84.0	

Table 4-5
Building 604 Compounds Detected above Residential SCTLs

Sample ID	Parameter	RSCTL	Result	Comment
038S0T4101	Copper	110	210.0	
038S0T4201	Copper	110	190.0 A	
IWTP Sewer Investigation Data				
036S073C02	Benzo(a)pyrene	100	210.0 J	
036S074C02	Arsenic	0.8	1.2	< Arsenic RC
	Benzo(a)pyrene	100	270.0 J	
036S074C04	Arsenic	0.8	2.0	
	Benzo(a)anthracene	1400	4,500.0	
	Benzo(a)pyrene	100	4,500.0	
	Benzo(b)fluoranthene	1400	8,300.0	
	Dibenz(a,h)anthracene	100	800.0 J	
	Indeno(1,2,3-cd)pyrene	1500	1,700.0	
036S074N02	Arsenic	0.8	6.4	
	Copper	110	607.0	
	Iron	23,000	24,900.0	
	Lead	400	949.0	
036S074W02	Arsenic	0.8	3.6	
	Copper	110	117.0	
	Lead	400	408.0	
	Benzo(a)pyrene	100	350.0 J	
036S075C02	Arsenic	0.8	0.9 J	< Arsenic RC
	Benzo(a)pyrene	100	310.0 J	
036S075E02	Arsenic	0.8	5.1 J	
	Copper	110	391.0	
	Lead	400	579.0 J	

Table 4-5
 Building 604 Compounds Detected above Residential SCTLs

Sample ID	Parameter	RSCTL	Result	Comment
036S075E06	Arsenic	0.8	2.6 J	
	Copper	110	129.0	
	Iron	23,000	32,900.0 J	
	Vanadium	15	21.5	
036S076C02	Arsenic	0.8	2.0 J	
036S076S02	Arsenic	0.8	1.3 J	
036S076W02	Benzo(a)pyrene	100	180.0 J	
036S076W04	Arsenic	0.8	1.3 J	< Arsenic RC
036S077C04	Arsenic	0.8	1.3 J	< Arsenic RC
036S077S02	Arsenic	0.8	1.3 J	< Arsenic RC
036S077W02	Arsenic	0.8	0.9 J	< Arsenic RC
	Benzo(a)pyrene	100	510.0	
036S078C02	Arsenic	0.8	0.9 J	< Arsenic RC
036S078E02	Arsenic	0.8	3.2 J	
	Copper	110	264.0	
036S078S02	Arsenic	0.8	1.1 J	< Arsenic RC
036S078W02	Vanadium	15	15.1 J	

Notes:

ISCTLs may be found in Appendix F.

J = Concentration is estimated.

All inorganic concentrations in mg/kg (milligrams per kilogram).

All organic concentrations in µg/kg (micrograms per kilogram).

Table 4-6
Comparison of Arsenic, Copper, and Vanadium Exceedances at Building 604

Arsenic		Copper		Vanadium	
Exposed Surface Soil	Below Pavement/Concrete	Exposed Surface Soil	Below Pavement/Concrete	Exposed Surface Soil	Below Pavement/Concrete
38S35 (-01, -03)	38S26 (-01, -03, -05)	B-T11 (-01)	38S26 (-01)	38S37 (-01)	38S26 (-01)
38S37 (-01)	38S36 (-01, -03)	B-T31 (-01)	38S41 (-01)	B-T01 (-01)	38S35 (-01)
B-T01 (-01)	B-T14 (-01)	B-T37 (-01)	36SB74N (-02)	B-T08 (-01)	38S36 (-01)
B-T11 (-01)	B-T15 (-01)	B-T41 (-01)	36SB74W (-02)	B-T09 (-01)	B-T13 (-01)
B-T16 (-01)	B-T19 (-02)	B-T42 (-01)	36SB75E (-02, -06)	B-T16 (-01)	B-T14 (-01)
B-T17 (-01)	36SB74C (-04)		36SB78E (-02)	B-T18 (-01)	B-T19 (-01)
B-T18 (-01)	36SB74N (-01)				36SB75E (-06)
B-T23 (-01)	36SB75E (-02, -06)				36SB78W (-02)
B-T25 (-01)					

Table 4-7
Building 604 Compounds Detected above Industrial SCTLs

Sample ID	Parameter	ISCTL	Result
RI Data			
038S002601	Arsenic	3.7	4.2
038S002605	Arsenic	3.7	7.5
038S003501	Arsenic	3.7	21.1
	Arsenic	3.7	7.2
038S003603	Arsenic	3.7	8.2
EPA Data			
038S0T0101	Arsenic	3.7	5.1
038S0T1101	Arsenic	3.7	4.0
038S0T1401	Arsenic	3.7	8.7
038S0T1501	Arsenic	3.7	5.7

Table 4-7
Building 604 Compounds Detected above Industrial SCTLs

Sample ID	Parameter	ISCTL	Result
038S0T1601	Arsenic	3.7	5.6
038S0T1701	Arsenic	3.7	6.3
038S0T2701	Benzo(a)pyrene	500	2,200.0 J
IWTP Data			
036S074C04	Benzo(a)pyrene	500	4,500.0
	Benzo(b)fluoranthene	4800	8,300.0
	Dibenz(a,h)anthracene	500	800.0 J
036S074N02	Arsenic	3.7	6.4
	Lead	920	949.0
036S075E02	Arsenic	3.7	5.1 J
036S077W02	Benzo(a)pyrene	500	510.0

Notes:

ISCTLs may be found in Appendix F.

J = Concentration is estimated.

All inorganic concentrations in mg/kg (milligrams per kilogram).

All organic concentrations in $\mu\text{g/kg}$ (micrograms per kilogram).

the ISCTLs for PAHs). Assuming surface soil impacts are confined to within a 20-foot radius of each exceedance, approximately 1,400 CY of soil exceed ISCTLs at this site. This assumes surface soil locations are excavated to a depth of 2 feet and all other locations are excavated to the contaminated interval. It is important to note that 90% of the Building 604 area is paved with either asphalt or concrete, and thus exposure pathways associated with industrial use are not currently viable.

4.1.2.3 Building 604 Comparison with Leaching Values Protective of Groundwater

The leaching potential for site soil was evaluated using FDEP's soil leaching criteria protective of groundwater (SL-GW); exceedances are shown in Table 4-8 and on Figure 4-7. The exceedances

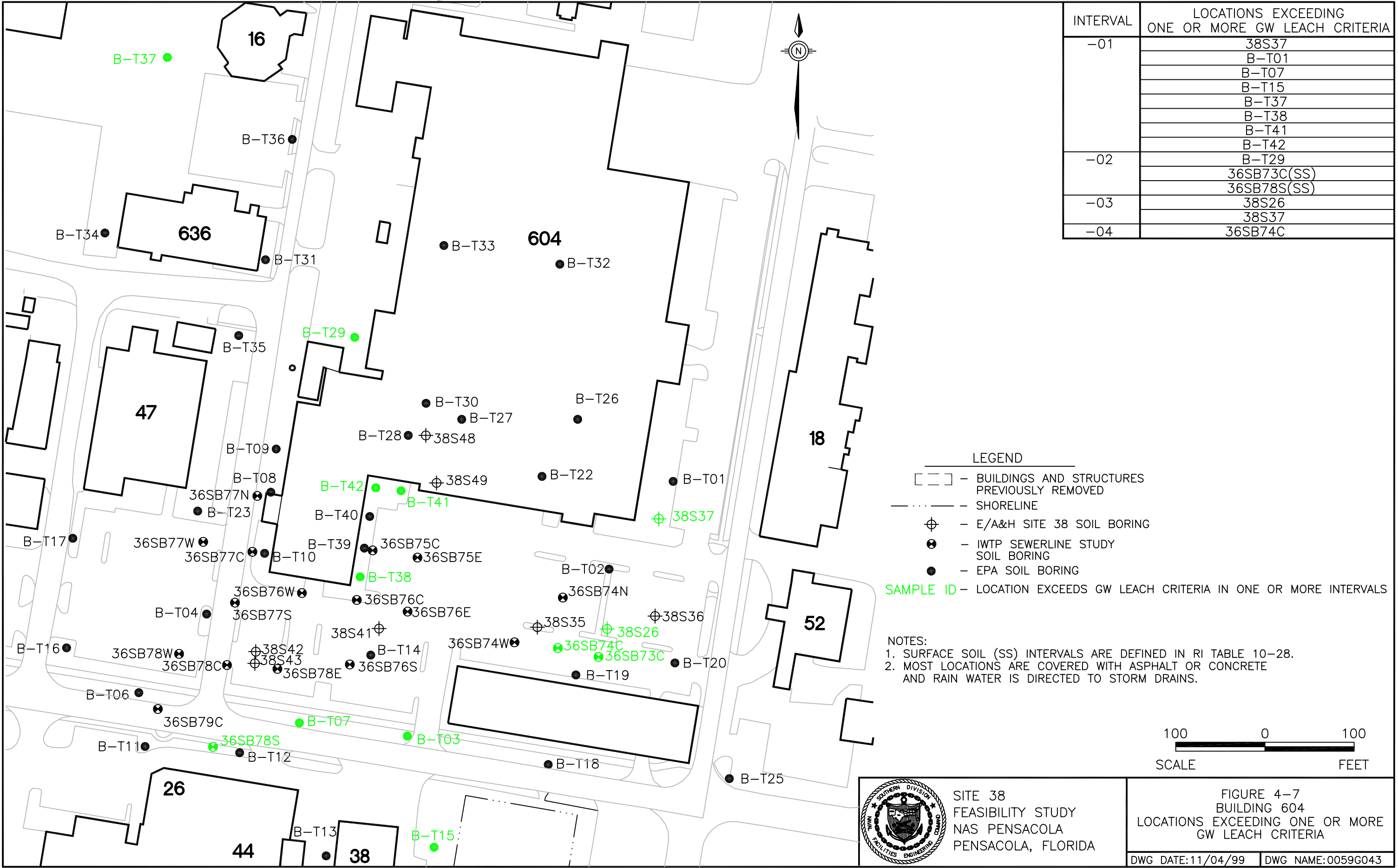


Table 4-8
Building 604 Compounds Detected above GW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-GW	Result
RI Data			
038S002603	Dieldrin	4	4.4 J
038S003701	Dieldrin	4	5.4
038S003703	Antimony	5	6.1
EPA Data			
038S0T0301	Dieldrin	4	20.0 J
038S0T0701	Dieldrin	4	9.0 JN
038S0T1501	Dieldrin	4	40.0 J
038S0T2902	Tetrachloroethene	30	34.0 J
038S0T3701	Dieldrin	4	84.0
038S0T3801	Chromium	38	48.0
	Dieldrin	4	5.3 J
038S0T4101	Cadmium	8	17.0
038S0T4201	Cadmium	8	21.0
	Chromium	38	40.0
	beta-BHC	1	56.0 N
	delta-BHC	200	300.0 N
IWTP Sewer Investigation Data			
036S073C02	Methylene chloride	20	730.0 J
036S074C04	Benzo(a)anthracene	3,200	4,500.0
036S078S02	Acetone	2,800	8,600.0

Notes:

ISCTLs may be found in Appendix F.

J = Concentration is estimated.

All inorganic concentrations in mg/kg (milligrams per kilogram).

All organic concentrations in µg/kg (micrograms per kilogram).

detected in soil were antimony, cadmium, chromium, benzo(a)anthracene, beta-BHC, delta-BHC, dieldrin, acetone, methylene chloride, and PCE. However, of these compounds, only cadmium, chromium, benzo(a)anthracene, acetone, and PCE were detected above groundwater criteria in the Building 604 area. These data indicate that other contaminants in soil are not appreciably leaching to groundwater.

Cadmium was detected in only two locations at concentrations above the SL-GW criteria: B-T41 (17 mg/kg) and B-T42 (21 mg/kg), both in the -01 interval. Cadmium was quantified above groundwater criteria in multiple wells during the RI (36GR75, 36GR76, 38S24, T-08, 38GI04, 38GS08, 38GS14, 38GS19, 38GS20, 38GS21) in the vicinity of B-T41 and B-T42. Concentrations in 38GS19, 382 $\mu\text{g/L}$ during the RI, had decreased to less than 1 $\mu\text{g/L}$ by 1998; the maximum detected concentration in groundwater during 1998 was 50 $\mu\text{g/L}$. These data suggest that contaminant attenuation since the RI has been significant, and that RI data are likely biased high due to groundwater sampling techniques.³ Soil characterized by B-T41 and B-T42 may not be contributing significantly to groundwater.

Chromium was detected in two locations, B-T38 (48 mg/kg) and B-T42 (40 mg/kg), both in the -01 interval, at concentrations only slightly exceeding the SL-GW (38 mg/kg). Chromium exceeded groundwater criteria in eight wells in the Building 604 area, 36GR76, 36GR77, T-03, 38GI04, 38GS08, 38GS19, 38GS20, and 38GS21. As with cadmium, chromium concentrations in the most contaminated well, 38GS19, have decreased from 544 $\mu\text{g/L}$ to 20 $\mu\text{g/L}$; in groundwater decreased significantly when data collected in 1998 are compared with RI data: again, 1998 data are likely more reliable due to sampling technique. This decrease in

³All wells sampled during the initial RI were sampled using bailers; subsequent sampling events were performed using micropurging techniques to minimize sample turbidity and suspended solids. Well data obtained after the RI are regarded as a more reliable representation of aquifer inorganic concentrations.

concentrations to below groundwater criteria indicates that the soil around borings B-T38 and B-T42 is not contributing significantly to groundwater.

Benzo(a)anthracene was quantified in one soil boring, 36SB74C (-04), at concentrations exceeding the SL-GW criteria. This location is beneath an asphalt parking lot, and therefore various PAHs could be expected in underlying soil due to natural leaching processes. However, groundwater exhibiting benzo(a)anthracene concentrations above groundwater criteria was encountered in well 36GR77C, west and sidegradient of 36GR74C. Downgradient wells do not exhibit benzo(a)anthracene contamination. Therefore, data indicate that 36GR74 is not a significant source of contaminants leaching to groundwater.

Acetone was quantified in only one soil boring, 36SB78S (-02), at concentrations exceeding the SL-GW criteria. Acetone was quantified in groundwater in a number of wells at Building 604, but all are upgradient of the soil boring location and all were below groundwater criteria. Downgradient wells did not exhibit acetone contamination in excess of groundwater criteria. Therefore, acetone contamination at 36SB78S is not considered a threat to groundwater.

PCE was quantified in only one boring just west of Building 604, B-T29, at a concentration of 34 $\mu\text{g}/\text{kg}$. Multiple wells downgradient of this location exhibit PCE concentration, but most notable is the PCE concentration in upgradient well T-31, which suggest that PCE is leaching into the aquifer at an upgradient source (possibly the dry-cleaning facility at Building 636). Moreover, PCE contamination in the aquifer has decreased significantly since the RI: data collected in 1998 indicate reductions of 50 to 100%, attributable to natural attenuation processes. Because PCE was not quantified in collocated boring 38S30, in either the -01 or -03 intervals, this location is not regarded as a significant threat to groundwater.

4.1.2.4 Building 604 Comparison with Leaching Values Protective of Water Bodies

Thirty locations out of 64 exceeded soil leaching values protective of marine surface water. Marine criteria were assessed because the Building 604 area abuts Pensacola Bay. Exceedances are identified in Table 4-9, and shown on Figure 4-8.

Compounds exceeding criteria included: mercury, acenaphthylene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, chrysene, fluoranthene, phenanthrene, pyrene, Aroclor 1254, Aroclor 1260, beta-BHC, 4,4'-DDE, dieldrin, endosulfan I, endrin, endrin aldehyde, acetone, and PCE. Of these compounds, only mercury, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, fluoranthene, pyrene, acetone, and PCE were detected in groundwater at Building 604, indicating that the remaining compounds were not leaching appreciably to groundwater.

Mercury is ubiquitous across the site, ranging in concentration from below the NAS Pensacola RC of 0.1 mg/kg to a maximum of 1.0 mg/kg; only concentrations above the RC were evaluated during this screening. The following locations exhibited mercury concentrations greater than 0.1 mg/kg: 38S26 (-01, -03, -05), 38S35 (-01), B-T03 (-01), B-T04 (-02), B-T10 (-01), B-T11 (-01), B-T12 (-01), B-T13 (-01), B-T15 (-01), B-T16 (-01), B-T18 (-02), B-T20 (-02), B-T35 (-01), B-T38 (-01), B-T41 (-01), 36SB73C (-04), 36SB74C (-02), 36SB74N (-02), 36SB75E (-02), 36SB76C (-02), 36SB76W (-04), and 36SB77W (-04). The areal extent of mercury contamination above SL-MSW is relatively large, extending across the width of the Building 604 area, but is discontinuous: contamination is present at T-B41, but not nearby borings B-T40 and B-T42. Similarly, mercury did not exceed the RC between 36SB76C and B-T03 to the southeast. Moreover, mercury is not present at concentrations exceeding the SL-MSW criteria at all depths, and therefore does not appear to be a significant leaching source. Mercury was only quantified in a small subset of wells in the Building 604 area, including 36GR73C, 36GR74C, 36GR76C, 38GI04, 38GS07, 38GS03, and 38GW09. Downgradient wells did not exceed MSW criteria. These data suggest that mercury does not pose a threat to marine surface water.

Table 4-9
Building 604 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result
RI Data			
038S002601	Mercury	0.01	0.15 J
038S002603	Mercury	0.01	0.13 J
	Dieldrin	0.1	4.40 J
038S002605	Mercury	0.01	0.60 J
038S003501	Mercury	0.01	0.23
038S003701	Aroclor-1260	2	570.00 J
	Dieldrin	0.1	5.40
	Endrin aldehyde	1	29.00 J
038S004202	Mercury	0.01	0.10 < Mercury RC
038S004204	Mercury	0.01	0.09 < Mercury RC
038S004206	Mercury	0.01	0.10 < Mercury RC
EPA Data			
038S0T0101	Aroclor-1254	2	810.00
038S0T0301	Mercury	0.01	0.12
	Dieldrin	0.1	20.00 J
038S0T0302	Mercury	0.01	0.10 < Mercury RC
038S0T0401	Mercury	0.01	0.07 < Mercury RC
	Dieldrin	0.1	3.10 J
038S0T0402	Mercury	0.01	0.82
038S0T0701	Mercury	0.01	0.08 < Mercury RC
	Dieldrin	0.1	9.00 JN
038S0T1001	Mercury	0.01	0.17
038S0T1002	Mercury	0.01	0.08 < Mercury RC
038S0T1101	Mercury	0.01	0.22
038S0T1201	Mercury	0.01	0.12
038S0T1301	Mercury	0.01	0.36

Table 4-9
Building 604 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result
038S0T1501	Mercury	0.01	0.22
	Dieldrin	0.1	40.00 J
038S0T1601	Mercury	0.01	0.14
038S0T1702	Mercury	0.01	0.07 < Mercury RC
038S0T1801	Aroclor-1254	2	83.00 J
038S0T1802	Mercury	0.01	1.00
038S0T1902	Mercury	0.01	0.05 < Mercury RC
038S0T2002	Mercury	0.01	0.17
038S0T2301	Mercury	0.01	0.07 < Mercury RC
038S0T2701	Benzo(a)anthracene	700	2,600.00 J
	Benzo(a)pyrene	1,200	2,200.00 J
	Benzo(b)fluoranthene	1,600	3,800.00
	Chrysene	700	2,200.00 J
	Fluoranthene	1,300	3,700.00
	Pyrene	1,300	3,500.00
038S0T2702	Mercury	0.01	0.07 < Mercury RC
038S0T3101	Mercury	0.01	0.07 < Mercury RC
	4,4'-DDE	100	120.00
038S0T3501	Mercury	0.01	0.85
038S0T3502	Mercury	0.01	0.09 < Mercury RC
038S0T3601	Mercury	0.01	0.08 < Mercury RC
038S0T3701	Dieldrin	0.1	84.00
038S0T3801	Mercury	0.01	0.07 < Mercury RC
	Dieldrin	0.1	5.30 J
038S0T3901	Mercury	0.01	0.10 < Mercury RC
038S0T4001	Mercury	0.01	0.08 < Mercury RC
038S0T4101	Mercury	0.01	0.23

Table 4-9
Building 604 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result
038S0T4201	beta-BHC	3	56.00 N
	Endosulfan I	0.8	7.40 JN
	Endrin	1	7.10 JN
IWTP Sewer Investigation Data			
036S073C04	Mercury	0.01	0.14
036S074C02	Mercury	0.01	0.15
	Endrin	1	1.40 J
036S074C04	4,4'-DDT	60	63.00 J
	Endosulfan I	0.8	2.00 J
	Endrin	1	13.00
	Acenaphthylene	700	1,800.00
	Anthracene	700	1,000.00 J
	Benzo(a)anthracene	700	4,500.00
	Benzo(a)pyrene	1,200	4,500.00
	Benzo(b)fluoranthene	1,600	8,300.00
	Chrysene	700	4,200.00
	Fluoranthene	1,300	6,700.00
	Phenanthrene	700	3,100.00
	Pyrene	1,300	9,300.00
036S074N02	Mercury	0.01	0.44
036S074W02	Mercury	0.01	0.07 < Mercury RC
036S075C02	Endrin	1	2.70 J
036S075C04	Mercury	0.01	0.09 < Mercury RC
036S075E02	Mercury	0.01	0.34
	Dieldrin	0.1	1.40 J
	Endrin	1	9.90
036S075E06	Endrin	1	3.40 J

Table 4-9
Building 604 Compounds Detected above MSW Criteria (Leachability) SCTLs

Sample ID	Parameter	SL-SW	Result
036S076C02	Mercury	0.01	0.15
	Endrin	1	1.80 J
036S076E02	Endrin	1	3.40
	Mercury	0.01	0.08 < Mercury RC
036S076S02	Mercury	0.01	0.09 < Mercury RC
036S076W04	Mercury	0.01	0.14
036S077C04	Mercury	0.01	0.09 < Mercury RC
	4,4'-DDE	100	140.00 J
	Aroclor-1254	2	30.00 J
	Aroclor-1260	2	42.00
036S077W04	Mercury	0.01	0.15
036S078C02	Mercury	0.01	0.06 < Mercury RC
036S078C04	Dieldrin	0.1	1.60 J
	Endrin	1	1.10 J
036S078E02	Mercury	0.01	0.10 < Mercury RC
	Dieldrin	0.1	0.94 J
	Endrin	1	7.80
	Mercury	0.01	0.09 < Mercury RC
	Acetone	6,800	8,600.00
036S078W02	Dieldrin	0.1	15.00 J
	Endrin	1	3.30 J

Notes:

SL-SW may be found in Appendix F.

J = Concentration is estimated.

All inorganic concentrations in milligrams per kilogram (mg/kg).

All organic concentrations in micrograms per kilogram (µg/kg).

Various PAHs (anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, fluoranthene, pyrene) were detected above SL-MSW criteria in soil at locations B-T27 (-01), in the central part of Building 604, and 36SB74C (-04), in the southeast corner of the parking lot. Only two wells contained PAHs at concentrations exceeding SL-MSW: 36GR77C and 38GS18. The wells and the soil exceedances are not collocated; however, with the exception of B-T27, the borings and wells were completed through or adjacent to asphalt parking areas. PAHs would be expected in soil adjacent to or underlying asphalt pavement. PAHs were not detected in downgradient locations, therefore they are not considered a threat to marine surface water bodies.

Acetone was quantified in only one soil boring, 36SB78S (-02), at concentrations exceeding the SL-MSW criteria. Acetone was not quantified above MSW criteria in any Building 604 wells. Therefore, acetone contamination at 36SB78S is not considered a threat to groundwater.

PCE was quantified above the SL-MSW criterion in only one boring just west of Building 604, B-T29, at a concentration of 34 $\mu\text{g/kg}$. Multiple wells downgradient of this location exhibit PCE concentrations exceeding levels protective of marine surface water, but most notable is the PCE concentration in upgradient well T-31, which suggest that PCE is leaching into the aquifer at an upgradient source (possibly the dry-cleaning facility at Building 636). Moreover, PCE contamination in the aquifer has decreased significantly since the RI: data collected in 1998 indicate reductions of 50 to 100%, attributable to natural attenuation processes. Downgradient monitoring wells meet groundwater standards for discharge to marine surface water bodies. Because PCE was not quantified in collocated boring 38S30, in either the -01 or -03 intervals, this location is not regarded as a significant threat to groundwater.

4.2 Site 38 Remedial Goals

RGs for Site 38 have been proposed for the protection of human health and the environment given current and future land use. Site 38 has historically been used for industrial purposes, as described

in Section 1; future use is expected to remain the same. Future risk to human health will be minimized by maintaining Site 38 as an industrial site. Institutional controls will be required for both soil and groundwater to limit exposures above appropriate criteria.

RAOs

- Protect the health of current and future site workers. ISCTLs will be used as RGs.
- Protect the environment by ensuring soil-to-groundwater transfers are minimized.
- Protect the environment by minimizing transfer of contaminants to adjacent water bodies.

4.2.1 Surface Soil Remediation Goals

Surface soil RGs are based on ISCTLs, as land use conditions are not expected to change. Table 4-10 presents the RGs for surface soil at Site 38; only compounds exceeding an RG are shown in this table.

Table 4-10
Contaminant-Specific Remediation Goals for Surface Soil at Site 38

Contaminant	RG (in mg/kg)
Arsenic	3.7
Chromium (VI)	420
Lead	920
Aroclor 1254	2.1
Benzo(a)pyrene	0.5
Benzo(b)fluoranthene	4.8
Dibenz(a,h)anthracene	0.5

Note:

mg/kg = milligrams per kilogram

4.2.2 Subsurface Soil Remediation Goals

The Site 38 building complex is heavily industrial, and 90% of the Site 38 area is covered with buildings, concrete, or asphalt pavement. While these materials are somewhat permeable when compared to traditional clay- and RCRA-like caps, they are also significantly less permeable than underlying soil. Stormwater runs off to the stormwater collection system and thus infiltration in paved areas is minimal.

Based on a comparison of site analytical data with Florida leaching criteria, as discussed in Sections 4.1.1.3 and 4.1.2.3, although several contaminants were quantified above leaching criteria, many contaminants were not present in the aquifer or their location in the aquifer did not correlate with potential soil source areas. Moreover, contaminant distribution patterns were irregular, and did not suggest a definitive soil source area: there is no distinguishable source mass for site contaminants.

Based on the absence of source mass and the minimal amount of infiltration expected in paved areas, leaching is not expected to be a significant concern under current or projected future land use scenarios. Therefore, no subsurface remediation goals have been established for Site 38.

4.2.3 Soil Volumes

Table 4-11 identifies locations exceeding one or more ISCTLs. This table also identifies surface soil conditions and impacted soil volumes associated with each location.

Table 4-11
 Site 38 Surface Soil Volumes Exceeding RGs

Location	Impacted Intervals	Contaminant	Concentration (in mg/kg)	Comment	Exposed Volume
BUILDING 71					
38S12	-04	Arsenic	15.6	Beneath Building 71 foundation. Exposure pathway incomplete.	0
38S13	-01	Chromium	713	Beneath Building 71 foundation. Exposure pathway incomplete.	0
	-03	Chromium	553	Subsurface soil. Exposure pathway incomplete.	0
38S14	-01	Chromium	665	Beneath Building 71 foundation. Exposure pathway incomplete.	0
38S18	-01	Aroclor 1254	16	Beneath Building 71 foundation. Exposure pathway incomplete.	0
	-03	Aroclor 1254	11	Subsurface soil. Exposure pathway incomplete.	0
	-05	Aroclor 1254	8	Subsurface soil. Exposure pathway incomplete.	0
38S32	-01	Arsenic	3.9	Paved with asphalt.	0
		Benzo(a)pyrene	0.69	Exposure pathway incomplete.	
38S34	-04	Dibenz(a,h)anthracene	0.59	Paved with asphalt. Exposure pathway incomplete.	0
BUILDING 604					
38S26	-01	Arsenic	4.2	Paved with asphalt. Exposure pathway incomplete.	0
	-05	Arsenic	7.5	Subsurface soil. Exposure pathway incomplete.	0

Table 4-11
 Site 38 Surface Soil Volumes Exceeding RGs

Location	Impacted Intervals	Contaminant	Concentration (in mg/kg)	Comment	Exposed Volume
38S35	-01	Arsenic	7.2	Median or grassy area.	5 feet wide by 35 feet long. Assuming 2 foot depth, 13 CY.
38S36	-03	Arsenic	8.2	Subsurface soil. Exposure pathway incomplete.	0
B-T01	-01	Arsenic	5.1	Median or grassy area.	40 feet wide by 40 feet long. Assuming 2 foot depth, 119 CY.
B-T11	-01	Arsenic	4.0	Median or grassy area.	20 feet wide by 20 feet long. Assuming 2 foot depth, 30 CY.
B-T14	-01	Arsenic	8.7	Paved with asphalt. Exposure pathway incomplete.	0
B-T15	-01	Arsenic	5.7	Median or grassy area.	50 feet wide by 40 feet long. Assuming 2 foot depth, 148 CY.
B-T16	-01	Arsenic	5.6	Median or grassy area.	30 feet wide by 30 feet long. Assuming 2 foot depth, 67 CY.

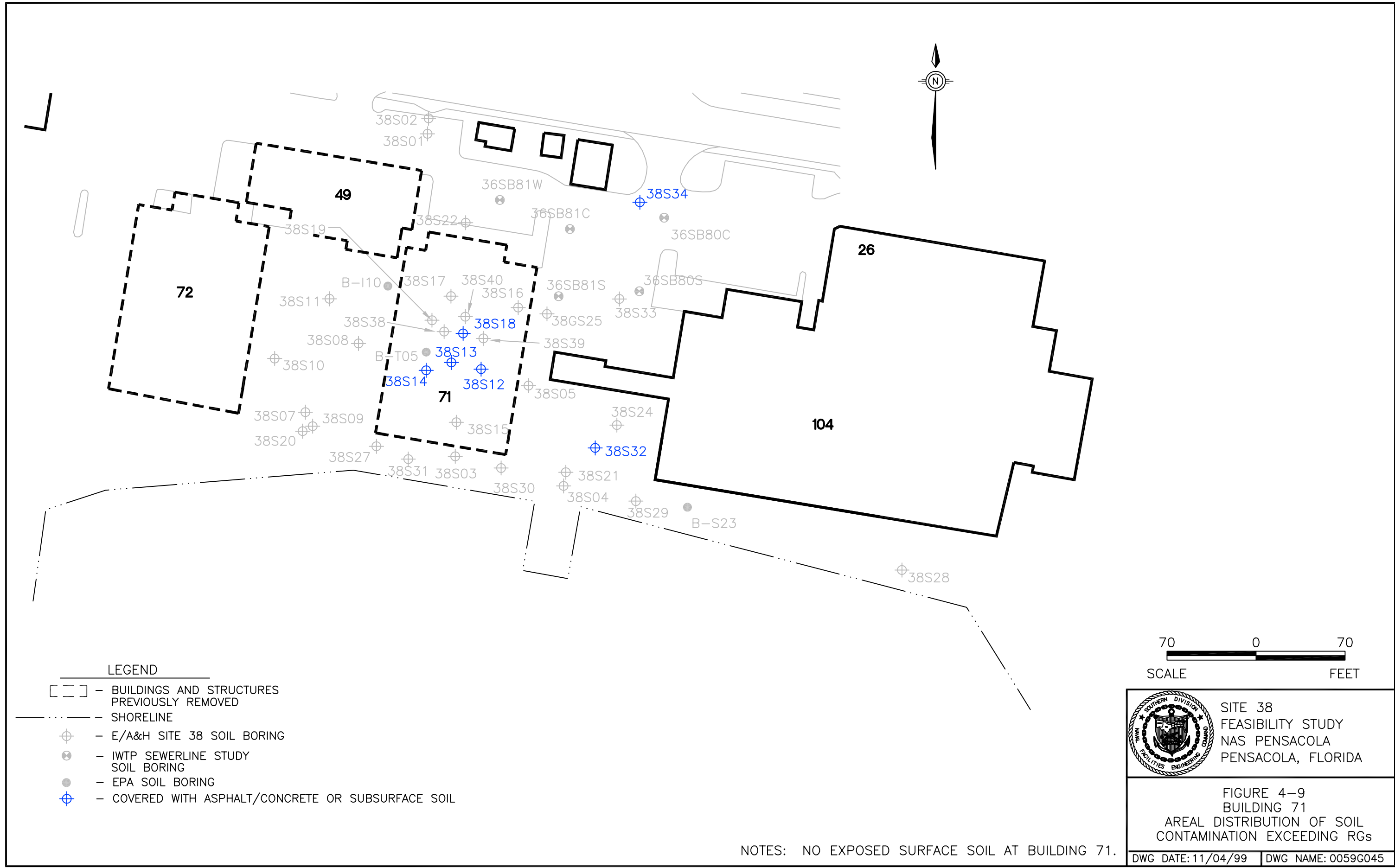
Table 4-11
 Site 38 Surface Soil Volumes Exceeding RGs

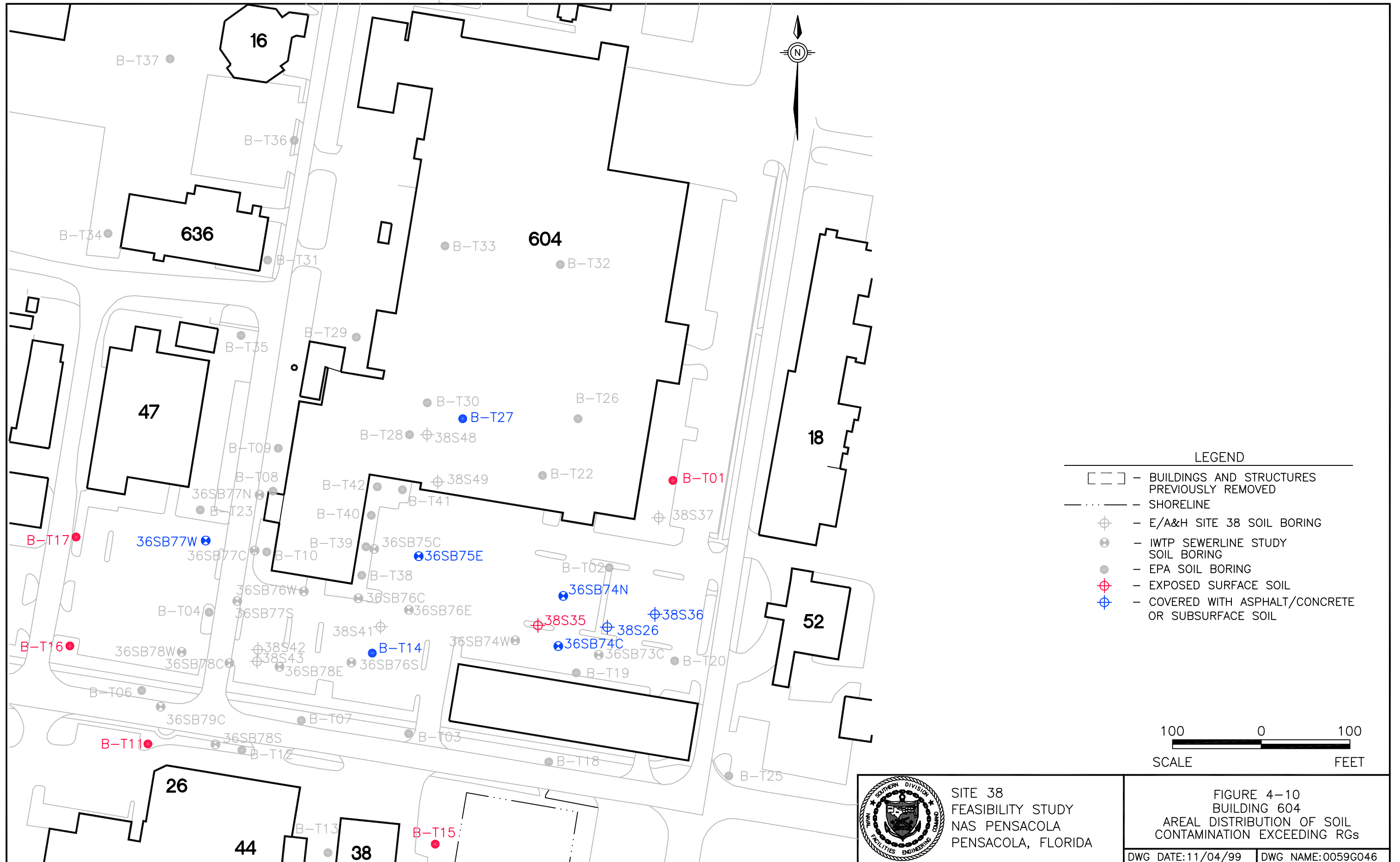
Location	Impacted Intervals	Contaminant	Concentration (in mg/kg)	Comment	Exposed Volume
B-T17	-01	Arsenic	6.3	Median or grassy area.	10 feet wide by 40 feet long. Assuming 2 foot depth, 30 CY.
B-T27	-01	Benzo(a)pyrene	2.2	Beneath Building 604 foundation. Exposure pathway incomplete.	0
36SB74C	-04	Benzo(a)pyrene	4.5	Subsurface soil.	0
		Benzo(b)fluoranthene	8.3	Exposure pathway incomplete.	
		Dibenz(a,h)anthracene	0.8	Exposure pathway incomplete.	
36SB74N	-02	Arsenic	6.4	Paved with asphalt.	0
		Lead	949	Exposure pathway incomplete.	
36SB75E	-02	Arsenic	5.1	Paved with asphalt. Exposure pathway incomplete.	0
36SB77W	-02	Benzo(a)pyrene	0.51	Paved with asphalt. Exposure pathway incomplete.	0

Notes:

mg/kg = milligram per kilogram
 J = Concentration is estimated
 ft = foot
 CY = cubic yard

The total volume of exposed surface soil impacted at Site 38 is approximately 407 CY. Of this volume, almost all is found in parking lot medians and/or grassy areas around functioning industrial-use buildings. The areal distribution of contaminated media at Building 71 and Building 604 are shown in Figures 4-9 and 4-10, respectively.





4.3 Site 38 Soil Alternatives

The total volume of exposed surface soil impacted at Site 38 is relatively small, approximately 400 CY, and includes a parking lot median as well as five small, discontinuous areas at the edges of the Building 604 complex parking lots. Arsenic is the sole constituent of concern in exposed surface soils at Site 38. Exceedances range from a approximately 4.0 mg/kg to a maximum of 7.2 mg/kg, less than two times the ISCTL.⁴

Because current and projected land use is expected to remain industrial, and the impacted locations comprise roughly 5,500 square feet, or 3% of the total surface area at Site 38, a full remedial technology screening was not performed. A limited number of alternatives, consistent with site use projections, were retained for evaluation:

- No Action, as required by the NCP.
- Institutional controls, which will be needed to maintain the industrial-use classification
- Capping

Excavation with offsite disposal was not considered for the Site 38 area because:

- Site 38 is one of the oldest areas of NAS Pensacola and is of significant archeological interest. Intrusive activities may disturb historically significant areas and/or arouse community objection.
- Due to its age, significant underground utilities are present in the Site 38 area. Excavation in an area with significant subsurface utilities was deemed impractical.

⁴ Assuming that the ISCTL represents an industrial site worker risk of 1E-06, the maximum arsenic concentration in exposed surface soil at Site 38 represents a theoretical risk of 2E-06, slightly above the CERCLA de minimis threshold of 1E-06. Actual risk is expected to be less, as workers will not be in contact with soil exceeding the ISCTL for the duration of time assumed during industrial site worker calculations.

4.3.1 Alternative S1: No Action

Under this alternative, no changes would be made to existing site operations or exposure scenarios. While the current and projected land use for this site is expected to remain industrial, there are no institutional controls to guarantee the exposure pathway would remain industrial. Without controls, a residential scenario must be assumed in which all existing pavement and buildings are removed.

Implementability

The no-action alternative could be easily implemented. The Navy would be required to perform a 5-year review to assess adequacy of the alternative.

Effectiveness

Technically, the no-action alternative is not effective at protecting human health, as contaminants above residential and industrial SCTLs are left onsite. Residential exposures, however, are unlikely given the current and future projected uses at Site 38.

Cost

Table 4-12 presents the costs associated with the no-action alternative.

Table 4-12
Alternative S1 — Costs for No Action

Action	Quantity	Cost per Unit	Total Cost
Five Year Review	LS	\$10,000	\$10,000
Present value subtotal (at 6% discount over 30 years)			\$24,4
Alternative S1 Total			\$24,400 *

Notes:

LS = Lump sum

* Cost based on review once every five years for 30 years.

4.3.2 Alternative S2: Institutional Controls

No remedial actions will be implemented under this alternative. Institutional controls, such as the LUCAP, would be implemented to limit access and property use to industrial/commercial, thereby limiting unacceptable exposure to contamination.

This alternative does not require any changes to existing activities, since current land use at Site 38 is industrial. However, controls would be required to minimize exposures which could include maintenance activities in impacted areas. Notification of the Base Environmental office would be required to ensure proper instruction before invasive activities begin.

Implementability

Implementation of this alternative does not require any innovative technologies or construction activities; ongoing operations would not be interrupted. This alternative would require the Navy to control site access and keep its use industrial/commercial. Site access can be controlled through the LUCAP and/or warnings against excavation. The site would be inspected annually to ensure compliance with the LUCAP. If the property was no longer under direct Navy control, development of a deed restriction would be necessary. The Navy has base planners and attorneys on staff with experience to develop and implement proper institutional controls for Site 38. The possibility of transferring Site 38 to civilian control is highly unlikely in the near future; therefore, proper controls can be implemented through planning. Given the historical significance of the Site 38 area, land use controls should require that any individuals performing archaeological investigations in the Site 38 area are notified of residual contamination so proper health and safety procedures can be maintained.

The NCP requires any alternative which leaves contamination onsite to be reevaluated every 5 years to ensure its adequacy. Therefore, the institutional controls alternative would require the Navy to establish a monitoring program.

Effectiveness

Institutional controls at Site 38 would limit unacceptable exposure to surface soil contamination. Under current site conditions, surface soil exceeds ISCTLs at five sample locations where surface soil is exposed. This alternative would not provide any additional effectiveness for the current use scenario, but would provide long-term effectiveness by restricting future use and access. Current exposure to impacted areas is expected to be minimal, however, as the impacted area is roughly 3% of the total area of Site 38. These areas are grassy medians or areas abutting parking lots and buildings. Industrial worker exposures are expected to be minimal, as parking lot medians and surrounding grassy areas are not work areas: exposure to impacted soil (if any) is expected to be a shorter duration (measured in minutes per day) than that typically assumed during risk/exposure calculations (e.g., 8 hours a day, 250 days per year, 30 years, etc.). No risks are posed during implementation of institutional controls.

This alternative also ensures that intrusive activities are not permitted in or near other impacted areas where concentrations exceed ISCTLs without proper notification and health-and-safety procedures.

If construction and industrial applications were to be implemented in contaminated areas, significant site development would be required; land-use restrictions could include a provision that development be accompanied by removal actions.

Cost

The total present-worth cost of the institutional controls alternative is estimated at \$74,400.

As shown in Table 4-13, the Navy assumes implementation of institutional controls will cost approximately \$50,000, which is the estimated cost for completing the necessary documentation and annual review of site use. In addition, a 5-year reevaluation of site conditions will be required

for 30 years, as per the NCP. The estimated cost for each reevaluation is \$10,000 per event; assuming a 6% discount rate over 30 years, the present worth of reevaluation requirements is approximately \$24,400.

Table 4-13
Alternative S2 — Costs for Institutional Controls

Action	Quantity	Cost per Unit	Total Cost
Five Year Review	LS	\$10,000	\$10,000
Present value subtotal at 6% discount over 30 years			\$24,400*
Institutional Controls (LUCAP and Signs)	LS	\$50,000	\$50,000
Alternative S2 Total			\$74,400

Notes:

LS = lump sum.

* Cost based on review once every five years for 30 years.

Remedial activities for the asphalt cover would consist of:

- Implementing institutional controls (LUCAP)
- Confirmatory sampling
- Site preparation
- Cover placement

Cover construction would consist of a 4- to 8-inch asphalt pavement placed over contaminated soil areas. It is assumed that existing stormwater control systems are adequate to support additional runoff from the areas proposed for asphalt cover. Confirmation sampling would help delineate the extent of soil in which contaminant concentrations exceed the RG to ensure that all contaminated soil is covered.

Implementability

Cover construction with institutional controls is technically feasible at Site 38. The site is suitable for asphalt or concrete covering to protect site workers from contaminated soil and to control runoff; the covers would be an extension of existing pavement. Land use restrictions may be used to implement institutional controls. The Site 38 area that would be covered is shown in 4.3.3.

4.3.3 Alternative S3: Asphalt Cover

Installing an asphalt cover would reduce the risk of site workers contacting areas of exposed contaminated soil, thus eliminating exposure pathways. Institutional controls would also be incorporated to restrict future access to contaminated soil. Limited excavation would eliminate risk from isolated areas of contaminated soil. Figure 4-11; the total area to be covered is approximately 5,500 square feet (ft²). Actual areas to be covered would be determined in the field following confirmation sampling.

Effectiveness

Covers provide reliable protection against dermal contact with and ingestion of contaminated soil. They isolate contaminants exceeding risk and guidance concentrations in environmental media, but are not designed to manage solid or hazardous waste. Confirmation sampling will ensure the entire area exceeding RGs is covered. Once the cover is in place, institutional controls would help ensure continued cover effectiveness and regular maintenance would be required.

Cost

Table 4-14 presents the capital costs associated with installation of an asphalt cover and institutional controls.

Table 4-14
 Alternative S3 — Costs for Asphalt Cover

Action	Quantity	Cost per Unit	Total Cost
Capital Costs for Asphalt Cover			
Mobilization/Demobilization	LS	\$500	\$500
Grading/site preparation	610 yd ²	\$1.50/yd ²	\$900
Asphalt/Concrete Surface (8" depth)	5,500 ft ²	\$1.76/ft ²	\$9,700
Confirmation Sampling	14 samples (plus 2 QA/QC samples)	\$250/sample	\$4,000 *
Engineering/Oversight	LS	20% cost	\$3,000
Contingency/Miscellaneous	LS	25% cost	\$4,000
Capital Cost Subtotal			\$22,000
Remedial Contractor Cost			
Overhead, Operations, and Profit			\$100,000
Total Capital (Startup) Cost			\$122,000
Operation and Maintenance Cost			
Maintain cover (30 years)	610 yd ²	\$2/yd ²	\$1,200
Inspection	LS	\$500	\$500
O&M Subtotal			\$1,700
O&M Present Value (at 6% discount over 30 years)			\$23,000
Institutional Controls			
LUCAP and signs		LS	\$50,000
Alternative S3 Total			\$195,000

Notes:

LS = Lump sum

yd² = square yard

* Assumes one sample will be collected along each edge of the contaminated area. Samples will be analyzed for arsenic.

4.4 Site 38 Detailed Analysis of Alternatives

The following alternatives have been retained for Site 38 soil:

- Alternative S1: No Action
- Alternative S2: Institutional Controls
- Alternative S3: Asphalt Cover

Each alternative is evaluated according to the nine criteria discussed in Section 2, which have been divided into three categories — threshold, balancing, and modifying.

4.4.1 Alternative S1: No Action

The no-action alternative for Site 38 involves no active remedial effort. No actions will be taken to contain, remove, or treat soil contamination above RGs. Soil will remain in place. No engineering or institutional controls will be implemented. The no-action alternative provides a baseline against which other alternatives can be compared.

No Action: Threshold Criteria

Overall Protection of Human Health and the Environment: The no-action alternative provides no additional protection of human health and the environment. This alternative assumes that future use will be residential. Site 38 soil exceeds RSCTLs at 44 out of 99 locations (19 locations at Building 71 and 36 locations at Building 604). These exceedances would remain onsite, unmitigated.

Compliance with ARARs: Alternative 1 does not comply with the RGs developed for Site 38; moreover, contaminants will pose risk under an uncontrolled future use scenario. Florida Proposed Rule 62-777 is a TBC criteria for Site 38. No location- or action-specific ARARs are triggered by the no-action alternative.

No Action: Balancing Criteria

The primary balancing criteria are the technical criteria on which the detailed analysis is based.

Long-Term Effectiveness and Permanence: Long-term effectiveness of Alternative 1 is minimal. Soil volumes and concentrations would remain unchanged. In addition, this alternative does not reduce the magnitude of residual risk, and lacks treatment actions that would provide permanence.

Any controls currently in place at the site — military security and limited access to/use of the site — would remain. If use were unrestricted, no controls would be in place to protect potential receptor groups (i.e., residents).

Reduction of Toxicity, Mobility, or Volume Through Treatment: This alternative would not reduce soil contaminant mobility, toxicity, or volume. Contaminants would remain untreated and in place.

Short-Term Effectiveness: Short-term effectiveness assesses an alternative's effect on human health and the environment while it is being implemented. There are no such effects from the no-action alternative.

Implementability: The no-action alternative is technically feasible and easily implemented. No construction, operation, or reliability issues are associated with this alternative. Current access controls — including military security and limited personnel access to the site — have historically been reliable. No administrative coordination, offsite services, materials, specialists, or innovative technologies are required. There are no implementation risks associated with Alternative 1.

Cost: Costs include a site review and report preparation every five years for 30 years. Each review and report are estimated to cost \$10,000, with a present worth of \$24,400 for the 30-year period.

No Action: Modifying Criteria

The modifying criteria are assessed formally after the public-comment period. However, the criteria are factored into identifying the preferred alternatives, as far as they are known.

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment on this FS.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

4.4.2 Alternative S2: Institutional Controls

The institutional controls alternative for Site 38 involves no active remedial effort. No actions will be taken to contain, remove, or treat soil contamination above RGs. Soil would remain in place and institutional controls would be incorporated into the LUCAP to ensure Site 38 remains an industrial use area.

Institutional Controls: Threshold Criteria

Overall Protection of Human Health and the Environment: The institutional controls alternative provides additional protection of human health and the environment by reducing the potential for uncontrolled site access. By restricting use to industrial/commercial, future risks from residential ingestion of or contact with soil are eliminated. However, soil contamination at Site 38 exceeds industrial RGs and poses a threat under a future worker scenario: 21 out of 99 locations exceed one or more ISCTLs (six locations at Building 71 and 15 locations at Building 604). Of these

locations, only six are exposed surface soil: all exposed surface soil points are in the Building 604 complex. No ISCTL exceedances are exposed in the Building 71 area.

Compliance with ARARs: Alternative 2 does not comply with the RGs established for Site 38; as stated above, a total of 21 locations exceed RGs, but only six locations exhibit a viable exposure pathway. Florida Proposed Rule 62-777 is a TBC criteria. No location- or action-specific ARARs are triggered by the institutional controls alternative. Contaminated soil would remain above the RGs.

Institutional Controls: Balancing Criteria

The primary balancing criteria are the technical criteria on which the detailed analysis is based.

Long-Term Effectiveness and Permanence: The long-term effectiveness of institutional controls is limited to the ability to control access to contaminated soil. Soil volumes and concentrations would remain unchanged, and there are no treatment actions that would provide permanence.

Reduction of Toxicity, Mobility, or Volume Through Treatment: The institutional controls alternative would not reduce the mobility, toxicity, or volume of soil contaminants. Contaminants would remain untreated and in place onsite.

Short-Term Effectiveness: Short-term effectiveness assesses an alternative's effect on human health and the environment while it is being implemented. There are no short-term effects resulting from the institutional controls alternative.

Implementability: The institutional controls alternative is technically feasible and easily implemented. No construction issues are associated with this alternative. Current access controls — including military security and limited personnel access to the site — have historically

been reliable and will be supplemented through land use restrictions. Administrative coordination is required to implement institutional controls, but no offsite services, materials, specialists, or innovative technologies would be required. There are no implementation risks with Alternative 2.

Administratively, given the historical significance of the older parts of NAS Pensacola, which include Buildings 71 and 604, the alternative which provides maximum protectiveness with a minimum of disturbance is likely preferred. If future archeological work is undertaken in this area, the LUCAP will ensure that site controls and health and safety measures are used to address site contamination.

Cost: Costs include soil monitoring and report preparation every five years for 30 years, plus the cost of establishing the institutional controls. Each sampling and reporting event is estimated to cost \$10,000, with a present worth of \$24,400 for the 30-year period. Providing the necessary institutional controls is estimated to be a one-time cost of \$50,000, for a total cost of \$74,400.

Institutional Controls: Modifying Criteria

The modifying criteria are assessed formally after the public-comment period. However, the criteria are factored into identifying the preferred alternatives, as far as they are known.

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

4.4.3 Alternative S3: Asphalt Cover

This alternative uses a physical barrier to cover the exposed locations where contaminants exceed RGs. In conjunction with the cover alternative, land use will be restricted to industrial to minimize uncontrolled exposure and prevent cover disturbance.

Asphalt Cover: Threshold Criteria

Overall Protection of Human Health and the Environment: The asphalt cover would eliminate the threat of dermal and ingestive contact for current and future site workers. Contaminated soil would be left onsite indefinitely and the cover maintained to ensure adequate protection.

This alternative would protect human health and the environment by physically eliminating receptor pathways and controlling access through land use restrictions. Cover construction and maintenance would be easily implemented, and current site controls (site security, access control, and fencing) and the LUCAP would be adequate to ensure minimal disturbance. Short-term risks during implementation from inhalation and dermal contact would be minimal, and could be controlled using common engineering techniques and use of PPE.

Compliance with ARARs: The asphalt cover with associated institutional controls would comply with RGs for future industrial workers. The potential for contact with soil in which contaminants exceed ISCTLs is eliminated by removing the primary pathways. Under this alternative, a total of 21 locations would still exceed RGs, but exposure pathways (dermal contact, ingestion, and inhalation) would be eliminated using a cover.

The cover would isolate or eliminate contaminants exceeding RGs in environmental media, but not manage solid or hazardous waste. Site grading would need to comply with federal, state, and local air emissions and storm water control regulations. Remedial actions at Site 38 may trigger the following ARARs:

- Floodplain requirements as outlined in the *National Environmental Policy Act* (40 CFR Part 6 Appendix A), *Fish and Wildlife Coordination Act* (40 CFR 6.302).
- Storm water discharge requirements as outlined in the *Clean Water Act* (40 CFR 122, 125, 129, 136) and the *Florida Storm Water Discharge Regulations* (FAC 62-25).

Asphalt Cover: Balancing Criteria

Long-Term Effectiveness and Permanence: An asphalt cover would effectively reduce site worker dermal or ingestive contact with contaminated soil, and would require inspection and maintenance. Asphalt covers are generally reliable containment controls; if the asphalt degraded or was removed, repairs could be made to re-establish the cover's integrity.

This alternative eliminates residual risk to site workers by managing Site 38 as an industrial site and restricting land use. The use of these covered soil areas would be controlled institutionally.

Reduction of Toxicity, Mobility, or Volume Through Treatment: Constructing an asphalt cover at Site 38 would not remove, treat, or remediate the contaminated soil; it provides containment only. The cover is considered reversible, because contaminants exceeding RGs under the cover would remain onsite; if the cover fails because of poor maintenance, contaminants may be exposed. This alternative would not reduce toxicity, mobility, or volume through treatment, nor would it satisfy the statutory preference for treatment.

Short-Term Effectiveness: Adverse impacts to the surrounding environment are not anticipated during cover construction; engineering controls would be applied to manage storm water runoff and siltation. Once design plans are approved, actual cover construction would be expected to take less than one month. During construction, workers would be at risk for dermal or ingestive

contact with site contaminants; however, this risk would be reduced by proper site work practices and use of PPE.

Implementability: An asphalt cover with institutional controls and limited excavation is technically and administratively feasible. This alternative could be readily applied at the site, because the proposed areas to be covered are easily accessible. Current access controls have been reliable and will be supplemented through the LUCAP, and thus implementing this alternative would merely involve placement of the cover and implementation of the LUCAP. Future monitoring and maintenance would involve periodic visual inspections and repairing any damage or degradation. Repairs are easily implemented, and asphalt covering would not require any extraordinary services or materials.

Administratively, extending paved areas to eliminate exposure pathways for current and future industrial site workers does not impact the historical value of the Building 71 and Building 604 area. If future archeological work is undertaken in this area, the LUCAP will ensure that site controls and health and safety measures are used to address site contamination.

Cost: Costs for this alternative are detailed in Section 4.4.3. The total cost for Alternative 3 including the cover, institutional controls, excavation, and the corrective action contractor is \$195,000 (net present value). O&M costs comprise approximately 12% of the net present value.

Asphalt Cover: Modifying Criteria

State/Support Agency Acceptance: FDEP and the USEPA will have the opportunity to review and comment.

Community Acceptance: These criteria are generally not completed until after public comments on the RI/FS report and the proposed plan are received.

4.5 Site 38 Comparative Analysis of Alternatives

The Site 38 comparative analysis of alternatives is presented in Table 4-15.

Table 4-15
 Comparative Analysis of Site 38 Soil Alternatives

Evaluation Criteria	Alternative S1: No action	Alternative S2: Institutional Controls	Alternative S3: Asphalt Cover
Threshold Criteria			
Protection of human health and the environment (HH&E)	No action is implemented. Because the site's future use is uncontrolled and site contaminants exceed residential standards, there is potential risk to future site residents.	Institutional controls are implemented to restrict land use and therefore minimize uncontrolled exposures. Because locations exceed industrial standards, there is potential risk to current and future site workers.	Asphalt cover will eliminate the dermal contact, ingestion, and inhalation pathways. The LUCAP will limit site use to industrial, thus minimizing uncontrolled exposures.
Compliance with ARARs	Current conditions do not meet RGs. While risk is within USEPA's acceptable risk range, onsite risks exceed FDEP's threshold criteria of 1E-06.	Current conditions do not meet RGs. While risk is within USEPA's acceptable risk range, onsite risks exceed FDEP's threshold criteria of 1E-06.	Soil cover will eliminate surface soil pathways, and therefore meet RGs. Actions would require compliance with storm water and floodplain requirements.
Balancing Factors			
Long-term effectiveness and permanence	None.	Institutional controls are effective at limiting access. The LUCAP will need to be maintained.	Covers are effective at eliminating the risk pathway. Maintenance will be required to ensure effectiveness.
Reduction of Toxicity, Mobility, or Volume through Treatment	None.	None.	None.
Short-Term Effectiveness	No risks are associated with the no-action alternative.	No risks are associated with institutional controls.	Implementing the remedy will require less than 1 month; short-term exposures may be reduced by engineering controls and PPE.
Implementability	Technically and administratively feasible. Easily implemented.	Technically and administratively feasible. Easily implemented.	Technically and administratively feasible. Easily implemented.
Cost	Capital: none Annual: \$10,000, every 5 years PW: \$24,000	Capital: \$50,000 Annual: \$10,000, every 5 years PW: \$74,000	Capital: \$122,000 Annual: \$1,700 PW: \$195,000

Table 4-15
Comparative Analysis of Site 38 Soil Alternatives

Evaluation Criteria	Alternative S1: No action	Alternative S2: Institutional Controls	Alternative S3: Asphalt Cover
Modifying Criteria			
State/Support Agency Acceptance	FDEP and USEPA will have opportunity to review and comment on this technology.	FDEP and USEPA will have opportunity to review and comment on this technology.	FDEP and USEPA will have opportunity to review and comment on this technology.
Community Acceptance	Community acceptance will be established after the public comment period.	Community acceptance will be established after the public comment period.	Community acceptance will be established after the public comment period.

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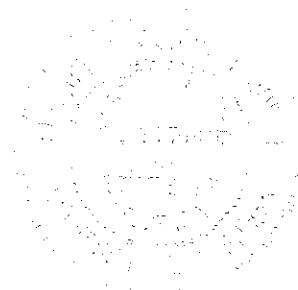
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6.0 FLORIDA PROFESSIONAL ENGINEER'S SEAL

I am registered to practice engineering by the Florida State Board of Professional Examiners (License No. 50413). I certify, under penalty of law, that the Feasibility Study Report for Naval Air Station Pensacola Site 38 was performed in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. To the best of my knowledge and belief, the information submitted is true, accurate, and complete; and the contents of this document are consistent with currently accepted engineering practices. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Elizabeth Claire Barnett
Elizabeth Claire Barnett

11-17-99
Date
License Expires February 28, 2001



Appendix A
Applicable or Relevant and Appropriate Requirements

Table 1
Potential Chemical-Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
Safe Drinking Water Act MCLs 40 CFR 141.11 - 141.16	Relevant and Appropriate	MCLs have been set for toxic compounds as enforceable standards for public drinking water systems. SMCLs are unenforceable goals regulating the aesthetic quality of drinking water.	The State of Florida considers all groundwater to be a potential potable water source. MCLs are relevant and appropriate to drinking water aquifers. Site 38 contaminants exceed MCLs.
Safe Drinking Water Act MCLGs 40 CFR 141.50-141.51	Relevant and Appropriate	MCLGs are unenforceable goals under the SDWA.	Per FDEP, the surficial zone of the Sand and Gravel Aquifer is a potential, although unlikely, source of drinking water. Some contaminants in the plume below Site 38 are above MCLGs.
Clean Water Act Federal Water Quality Criteria 51 Federal Register 43665	Applicable	Effluent limitations must meet Best Achievable Technology (BAT). Ambient Water Quality Criteria (AWQC) are provided for toxic chemicals.	Discharges to water bodies during remediation activities (if required) would have AWQCs as potential goal.
State Requirements			
Florida Drinking Water Standards, Monitoring, and Reporting Title 62 Chapter 62-550	Applicable	Establishes Primary and Secondary Drinking Water Standards (FPDWS and FSDWS).	The State of Florida considers all groundwater to be a potential potable water source. MCLs are relevant and appropriate to drinking water aquifers. Site 38 contaminants exceed MCLs. Some contaminants in the plumes below Site 38 are above the FPDWS and FSDWS.
UST, Drycleaners, and Brownsfields Cleanup Standards FAC 62-770, 62-781, and 62-785	To Be Considered	Establishes requirements for specific types of hazardous substance and petroleum-fuel cleanups.	Contaminants found at Site 38 are similar to contaminants covered by these regulations. These regulations have been applied at other locations at NAS Pensacola and, for consistency, should be considered in developing remedial solutions. The state has historically required use of UST regulations at the groundwater/surface water interface at NAS Pensacola CERCLA sites.

Table 1
Potential Chemical-Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Soil and Groundwater Cleanup Standards Florida Rule 62-777	To Be Considered	Establishes remediation targets for various soil and groundwater exposure scenarios; provides standards for assessing potential cross-media transfer.	Standards in this proposed rule are to be considered for actions at Site 38. Industrial use standards are appropriate soil remediation goals given current and future site use.
Florida Surface Water Quality Standards Title 62 Chapter 62-301 and 62-302	Applicable	Establishes water quality standards for all waters of the state.	Remedial objectives require protection of surficial water.

Table 2
Potential Location Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
Executive Order 11988 Floodplain Management Policy	To Be Considered	Establishes guidelines for activities conducted within a 100-year floodplain.	Site 38 is within a 100-year floodplain; however, Executive Order sets forth policy and is not enforceable.
National Environmental Policy Act 40 CFR Part 6, Appendix A	Applicable	Sets forth EPA policy carrying out the provisions of Executive Order 11988, Floodplain Management Policy, and Executive Order 11990, Wetlands Protection Policy.	Site 38 is located within a 100-year flood plain, and abuts wetlands areas. Remediation activities may disturb these areas.
Endangered Species Act (16 U.S.C. 1531 et seq.) 50 CFR Part 402 and Part 200	Applicable	Action must avoid jeopardizing the continued existence of listed endangered or threatened species or modification of their habitat.	Due to the proximity of Pensacola Bay to Site 38, endangered species may be present.
Fish and Wildlife Coordination Act (16 U.S.C. 661 et seq.) 33 CFR Part 320 to Part 330 40 CFR 6.302	Not Applicable	Requires actions to protect fish and wildlife from actions modifying streams or areas affecting streams.	Onsite actions are unlikely to generate impacts to adjacent water bodies.
National Historic Preservation Act of 1966 16 USC 1531 et seq. 36CFR Part 402	Relevant and Appropriate	Requires that the action not affect or cause harm to registered Historic Places or Historic Landmarks.	Site 38 is located in the oldest part of NAS Pensacola and is of significant archaeological interest. Special care must be taken with any remedy to preserve the area.
RCRA Location Requirements 40 CFR 264.18	Relevant and Appropriate	Sets forth minimum requirements for design, construction, and operation of a facility where treatment, storage, or disposal of hazardous waste will be within a 100-year floodplain.	Treatment, disposal, and storage of hazardous materials may take place during remediation of the site. Some wastes may be within the 100-year floodplain.

Table 2
Potential Location Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
State Requirements			
Florida Hazardous Waste Rules Title 62 Chapter 62-730	Relevant and Appropriate	Sets forth minimum requirements for design, construction, and operation of a facility where treatment, storage, or disposal of hazardous waste will be within a 100-year floodplain.	Treatment, disposal, and storage of hazardous wastes may take place during remediation of the site. Site 38 is in the 100-year floodplain.
UST, Drycleaners, and Brownsfields Cleanup Standards FAC 62-770, 62-781, and 62-785	To Be Considered	Establishes requirements for specific types of hazardous substance and petroleum-fuel cleanups.	Contaminants found at Site 38 are similar to contaminants covered by these regulations. These regulations have been applied at other locations at NAS Pensacola and, for consistency, should be considered in developing remedial solutions. The state has historically required use of UST regulations at the groundwater/surface water interface at NAS Pensacola CERCLA sites.

Table 3
Potential Action Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Federal Requirements			
RCRA Identification of Hazardous Waste 40 CFR 261	Applicable	Criteria for identifying those solid wastes subject to regulation as hazardous waste under RCRA.	Treatment residuals from onsite remediation activities may be hazardous waste. Proper disposal of treatment residuals will be required.
RCRA Generator Standards 40 CFR 262	Applicable	Establishes standards for generators of RCRA hazardous waste(s).	Treatment residuals from onsite remediation activities may be hazardous waste.
RCRA Facility Standards 40 CFR 264	Relevant and Appropriate	Establishes standards for the safe management and storage of RCRA hazardous waste(s).	Treatment residuals from onsite remediation activities may be hazardous waste.
RCRA Land Disposal Restrictions 40 CFR 268	Applicable	Certain classes of waste are restricted from land disposal without acceptable treatment.	If hazardous treatment residuals are disposed of offsite, they must comply with LDRs.
Clean Water Act National Pollutant Discharge Elimination System (NPDES) 40 CFR 122, 125, 129, 136	Applicable	Prohibits unpermitted discharge of any pollutant or combination of pollutants. Standards and limitations are established for discharges to waters of the U.S. from any point source.	Remedial actions may include the discharge of treated groundwater, runoff, or other flows to surface water.
Clean Water Act General Pretreatment Regulations for Existing and New Sources of Pollution 40 CFR 403	Applicable	Establishes the limits for the discharge of pollutants to publicly owned treatment works (POTW) and the requirement for pre-treatment if applicable.	Remedial actions may include the discharge of treated groundwater, runoff, or other flows to the federally owned treatment works (FOTW).
Department of Transportation Rules for the Transport of Hazardous Substances 49 CFR Parts 107 and 171-179	Applicable	Regulates the labeling, packaging, placarding, and transportation of solid and hazardous wastes offsite.	Remedial actions may include the offsite transport and disposal of solid and hazardous wastes.
Clean Air Act Permits Regulation 40 CFR 72	Relevant and Appropriate	Establishes requirements for major source permitting and operation.	Contaminants in groundwater include hazardous air pollutants (HAPs) and volatile organic compounds (VOCs). Remedial actions may include technologies that have air emissions.
Clean Water Act Wetlands Regulations Part 404 40 CFR 230	Not Relevant and Appropriate	Controls the discharge of dredged or fill materials into waters of the U.S. such that the physical and biological integrity is maintained.	Remedial actions are unlikely to impact water bodies.

Table 3
Potential Action Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
State Requirements			
Florida Air Pollution Rules - Stationary Sources Title 62 Chapter 62-210-General Requirements Chapter 62-296-Emission Standards	Applicable	Establishes emission standards, emission rates, baseline areas, and source classifications for protection of health and welfare. Identifies new source requirements, test, and analysis methods.	Remedial actions may include technologies that have air emissions.
Florida Air Pollution Rules - Operation Permits for Major Sources of Air Pollution Title 62 Chapter 62-213	Relevant and Appropriate	Establishes the operation permit system for major sources of air pollution (Title V sources).	Contaminants in groundwater include hazardous air pollutants (HAPs) and volatile organic compounds (VOCs). Remedial actions may include technologies that have air emissions.
Florida Air Pollution Rules - Stationary Sources Preconstruction Review Title 62 Chapter 62-212	Applicable	Establishes the general and specific pre-construction review process for those proposed activities for which a air construction permit applies.	Remedial actions may include technologies that have air emissions.
Florida Rules on Permits Title 62 Chapter 62-4	Relevant and Appropriate	Establishes requirements and procedures for all permitting required by the FDEP, and defines anti-degradation requirements.	Requirements may be applicable to site depending upon remedial actions and discharge options selected.
Florida Storm Water Discharge Regulations Title 62 Chapter 62-25	Applicable	Establishes design and performance standards and permit requirements for Storm water discharge facilities.	Remedial actions may impact Storm water discharge patterns at Site 38.

Table 3
Potential Action Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Florida Surface Water Quality Standards Title 62 Chapter 62-301 and 62-302	Applicable	Establishes water quality standards for all waters of the state.	Remedial objectives require protection of surficial water. Remedial actions may impact surficial water bodies if treated waters are discharged under a NPDES permit.
Florida Water Well Permitting and Construction Title 62 Chapter 62-532	Applicable	Establishes local criteria for design and installation of monitoring wells.	Installation of monitoring wells may be required.
Florida Hazardous Waste Rules Title 62 Chapter 62-730	Applicable	Establishes standards for generators and transporters of hazardous wastes	Treatment residuals from onsite remediation activities may be hazardous waste
Florida Hazardous Substance Release Notification Rules Title 62 Chapter 62-150	Applicable	Establishes notification requirements in the event of a hazardous substance release.	May be applicable if a hazardous substance is released in conjunction with remedial activities.
UST, Drycleaners, and Brownsfields Cleanup Standards FAC 62-770, 62-781, and 62-785	To Be Considered	Establishes requirements for specific types of hazardous substance and petroleum-fuel cleanups.	Contaminants found at Site 38 are similar to contaminants covered by these regulations. These regulations have been applied at other locations at NAS Pensacola and, for consistency, should be considered in developing remedial solutions. The state has historically required use of UST regulations at groundwater/surface water contact at NAS Pensacola CERCLA sites.
Florida Industrial Waste Water Facilities Title 62 Chapter 62-660	To Be Considered	Establishes the policy to encourage an applicant to study and evaluate treatment alternative techniques and to discuss alternatives with the FDEP.	Applicable if remedial actions generate waste waters to be treated on site prior to discharge to the navigable water ways of the U.S. by a NPDES permit.
Florida Water Quality Based Effluent Limitations Title 62 Chapter 62-650	Applicable	Establishes the requirements for the characterization of the effluent to be discharged from by an affected discharger	Applicable if remedial actions generate waste waters to be treated on site prior to discharge to the navigable water ways of the U.S. by a NPDES permit.

Table 3
Potential Action Specific ARARs
NAS Pensacola Site 38 (Operable Unit 11)

Requirements	Status	Requirement Synopsis	Application to the RI/FS
Florida Pretreatment Requirements for Existing and New Sources of Pollution Title 62 Chapter 62-625	Applicable	Establishes the requirements for pretreatment of waste waters prior to discharge to a publically owned treatment works (POTW).	Remedial actions may include the discharge of treated groundwater, runoff, or other flows to the federally owned treatment works (FOTW).
Florida Waste Water Facility Permitting Title 62 Chapter 62-620	Relevant and Appropriate	Establishes the procedure to obtain a permit to construct, modify, or operate a domestic or industrial waste water facility.	Applicable if remedial actions generate waste waters to be treated on site prior to discharge to the navigable water ways of the U.S.
Florida Underground Injection Control Chapter 62-528	Applicable	Established procedure and requirements for injection wells	Remedial actions may include the use of an injection well.

Appendix B
NAS Pensacola Background Concentrations

<p align="center">Table 1 Reference Concentrations for Soil (ppm)</p>		
Parameter	Mean Concentration	2 x Mean Concentration
Aluminum	1,916.68	3,833.36
Antimony	4.74	9.49
Arsenic	0.78	1.56
Barium	2.32	4.63
Beryllium	0.21	0.41
Cadmium	0.50	1.00
Calcium	456.18	912.37
Chromium	3.07	6.13
Cobalt	0.93	1.87
Copper	2.87	5.74
Cyanide	0.26	0.52
Iron	1,372.50	2,745.0
Lead	3.66	7.32
Magnesium	66.67	133.33
Manganese	10.68	21.36
Mercury	0.05	0.10
Nickel	3.19	6.38
Potassium	230.33	460.67
Selenium	0.31	0.62
Silver	1.03	2.07
Sodium	53.93	107.85
Thallium	0.41	0.82
Vanadium	2.91	5.83
Zinc	8.43	16.87

Source:

EnSafe/Allen & Hoshall (1994c). *Site 1 – Sanitary Landfill Remedial Investigation Report*. EnSafe/Allen & Hoshall: Memphis, Tennessee.

Notes:

All values are in milligrams per kilogram (mg/kg) or parts per million (ppm).

Table 2 Reference Concentrations for Groundwater (ppb) July 1994		
Parameter	Mean Concentration	2 x Mean Concentration
Aluminum	1,941.38	3,882.76
Antimony	15.1	30.2
Arsenic	1.4	2.8
Barium	6.61	13.22
Beryllium	0.55	1.1
Cadmium	1.7	3.4
Calcium	8,780.0	17,560.0
Chromium	17.49	34.98
Cobalt	2.05	4.1
Copper	8.1	16.2
Iron	853.9	1,707.8
Lead	0.8	1.6
Magnesium	1,436.25	2,872.5
Manganese	10.96	21.92
Mercury	0.1	0.2
Nickel	19.95	39.9
Potassium	6,083.8	12,167.6
Selenium	1.95	3.9
Silver	2	4
Sodium	9,172.5	18,345
Thallium	1.8	3.6
Vanadium	4.79	9.58
Zinc	76.6	153.2

Source:

EnSafe/Allen & Hoshall (1994c). *Site 1 – Sanitary Landfill Remedial Investigation Report*. EnSafe/Allen & Hoshall: Memphis, Tennessee.

Notes:

All values are in micrograms per liter ($\mu\text{g/L}$) or parts per billion (ppb).

Appendix C
Comparison of Groundwater Concentrations with SCTLs

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
ALUMINUM				200	13	2000
	036GR73C01	1993	14000.00	X	X	X
	036GR74C01	1993	1530.00	X	X	
	036GR75C01	1993	811.00	X	X	
	036GR76C01	1993	9120.00	X	X	X
	036GR77C01	1993	4100.00	X	X	X
	036GR78C01	1993	1030.00	X	X	
	036GR79C01	1993	7820.00	X	X	X
	036GR80C01	1993	7080.00	X	X	X
	036GR81C01	1993	1160.00	X	X	
	038GGI0101	1994	1410.00 J	X	X	
	038GGI0201	1994	1090.00 J	X	X	
	038GGI0301	1994	895.00 J	X	X	
	038GGI0401	1994	9110.00 J	X	X	X
	038GGI0701	1994	223.00	X	X	
	038GGI0801	1994	101.00 J		X	
	038GGI0901	1994	241.00 J	X	X	
	038GGS0101	1994	6420.00	X	X	X
	038GGS0201	1994	1330.00	X	X	
	038GGS0301	1994	2700.00	X	X	X
	038GGS0401	1994	658.00	X	X	
	038GGS0501	1994	3210.00	X	X	X
	038GGS0601	1994	30.90		X	
	038GGS0701	1994	320.00	X	X	
	038GGS0801	1994	792.00	X	X	
	038GGS0901	1994	3050.00	X	X	X
	038GGS1001	1994	8940.00	X	X	X
	038GGS1101	1994	991.00	X	X	
	038GGS1201	1994	11400.00	X	X	X
	038GGS1301	1994	2320.00	X	X	X
	038GGS1401	1994	688.00	X	X	
	038GGS1501	1994	300.00	X	X	
	038GGS1601	1994	877.00	X	X	
	038GGS1701	1994	180.00		X	
	038GGS1801	1994	1020.00	X	X	
	038GGS1901	1994	1860.00	X	X	
	038GGS2001	1994	20000.00	X	X	X
	038GGS2101	1994	2710.00	X	X	X
	038G0I0401	1995	78.00		X	
	038G0I0701	1995	74.00		X	
	038G0I0801	1995	56.00		X	
	038G0I0901	1995	75.00		X	
	038G0I1001	1995	2600.00	X	X	X
	038G0S0701	1995	57.00		X	
	038G0S1701	1995	55.00		X	
	038G0S1801	1995	64.00		X	
	038G0S2201	1995	52.00		X	

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
ALUMINUM				200	13	2000
	038G0S2301	1995	260.00	X	X	
	038G0S2401	1995	55.00		X	
	038G0S2501	1995	230.00	X	X	
	038G0S2601	1995	62.00		X	
	038G0S2701	1995	250.00	X	X	
	038G0S2801	1995	240.00	X	X	
	038G0S2901	1995	190.00		X	
	038G0S3001	1995	280.00	X	X	
	038G0S3101	1995	320.00	X	X	
	038G0S3201	1995	74.00		X	
	038G0T0501	1995	1800.00	X	X	
	038GS01	1998	730.00	X	X	
	038GS08	1998	250.00	X	X	
	038GS28	1998	90.00		X	
ANTIMONY				6	4300	60
	038GGS1001	1994	25.00 J	X		
	038GS03	1998	70.00	X		X
	038GS08	1998	210.00	X		X
	038GS12	1998	180.00	X		X
	038GS19	1998	60.00	X		
	038GS32	1998	190.00	X		X
ARSENIC				50	50	500
	036GR73C01	1993	1.80 J			
	036GR74C01	1993	4.60 J			
	036GR75C01	1993	4.30 J			
	036GR76C01	1993	11.00			
	036GR77C01	1993	3.80 J			
	036GR78C01	1993	1.50 J			
	036GR79C01	1993	3.20 J			
	036GR80C01	1993	4.30 J			
	036GR81C01	1993	2.10 J			
	038GGI0301	1994	3.90 J			
	038GGI0401	1994	4.80			
	038GGS0101	1994	21.80			
	038GGS0201	1994	10.80			
	038GGS0301	1994	5.70			
	038GGS0401	1994	13.00			
	038GGS0501	1994	7.30			
	038GGS0601	1994	35.70			
	038GGS0801	1994	4.00			
	038GGS0901	1994	5.80			
	038GGS1001	1994	24.00			
	038GGS1201	1994	102.00	X	X	
	038GGS1301	1994	7.90			
	038GGS1401	1994	4.00			
	038GGS1601	1994	6.10			
	038GGS1801	1994	5.30			
	038GGS1901	1994	12.50			
	038GGS2101	1994	5.70			
	038G0S2901	1995	12.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
ARSENIC					50	50 500
	038G0S3001	1995	17.00			
	038G0S3201	1995	8.40			
	038GS01	1998	17.00			
	038GS12	1998	6.00			
	038GS32	1998	5.00			
BARIUM					2000 <10% BKGD	20000
	036GR73C01	1993	102.00 J			
	036GR74C01	1993	196.00 J			
	036GR75C01	1993	111.00 J			
	036GR76C01	1993	109.00 J			
	036GR77C01	1993	39.40 J			
	036GR78C01	1993	84.50 J			
	036GR79C01	1993	150.00 J			
	036GR80C01	1993	77.80 J			
	036GR81C01	1993	48.50 J			
	038GGI0101	1994	25.60			
	038GGI0201	1994	47.20 J			
	038GGI0301	1994	15.50 J			
	038GGI0401	1994	16.60			
	038GGI0701	1994	9.30			
	038GGI0801	1994	5.60			
	038GGI0901	1994	11.20			
	038GGS0101	1994	104.00			
	038GGS0201	1994	21.60			
	038GGS0301	1994	79.60			
	038GGS0401	1994	30.00			
	038GGS0501	1994	80.70			
	038GGS0601	1994	77.90			
	038GGS0701	1994	55.80			
	038GGS0801	1994	173.00			
	038GGS0901	1994	59.30			
	038GGS1001	1994	34.00			
	038GGS1101	1994	27.00			
	038GGS1201	1994	152.00			
	038GGS1901	1994	104.00			
	038GGS2001	1994	98.60			
	038GGS2101	1994	168.00			
	038G0I0901	1995	22.00			
	038G0I1001	1995	11.00			
	038G0S0701	1995	68.00			
	038G0S0901	1995	59.00			
	038G0S1701	1995	58.00			
	038G0S1801	1995	99.00			
	038G0S2201	1995	46.00			
	038G0S2301	1995	22.00			
	038G0S2401	1995	44.00			
	038G0S2501	1995	58.00			
	038G0S2601	1995	69.00			
	038G0S2701	1995	49.00			
	038G0S2801	1995	30.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
BARIUM				2000	<10% BKGD	20000
	038G0S2901	1995	61.00			
	038G0S3001	1995	36.00			
	038G0S3101	1995	63.00			
	038G0S3201	1995	60.00			
	038G0T0501	1995	15.00			
	038GS01	1998	220.00			
	038GS03	1998	140.00			
	038GS08	1998	320.00			
	038GS12	1998	100.00			
	038GS19	1998	200.00			
	038GS28	1998	100.00			
	038GS32	1998	144.00			
BERYLLIUM				4	0.13	40
	038GGI0301	1994	1.20 J		X	
	038GGS1001	1994	1.00		X	
CADMIUM				5	9.3	50
	036GR75C01	1993	8.10	X	X	
	036GR76C01	1993	45.90	X	X	
	036GR77C01	1993	4.50 J			
	038GGI0401	1994	14.50	X	X	
	038GGS0501	1994	9.70	X	X	
	038GGS0801	1994	14.70	X	X	
	038GGS1201	1994	3.00			
	038GGS1301	1994	11.00	X	X	
	038GGS1401	1994	14.50	X	X	
	038GGS1601	1994	4.50			
	038GGS1901	1994	382.00	X	X	X
	038GGS2001	1994	34.10	X	X	
	038GGS2101	1994	336.00	X	X	X
	038G0S2401	1995	11.00	X	X	
	038G0S2701	1995	1.10			
	038G0S2901	1995	1.70			
	038GS08	1998	50.00	X	X	
	038GS12	1998	50.00	X	X	
	038GS19	1998	0.25			
CALCIUM				NOT AVAILABLE		
	036GR73C01	1993	48200.00			
	036GR74C01	1993	58200.00			
	036GR75C01	1993	48700.00			
	036GR76C01	1993	45600.00			
	036GR77C01	1993	66000.00			
	036GR78C01	1993	53000.00			
	036GR79C01	1993	39000.00			
	036GR80C01	1993	40800.00			
	036GR81C01	1993	56300.00			
	038GGI0101	1994	53300.00 J			
	038GGI0201	1994	72500.00 J			
	038GGI0301	1994	17100.00			
	038GGI0401	1994	59200.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
CALCIUM				NOT AVAILABLE		
	038GGI0701	1994	37000.00			
	038GGI0801	1994	26700.00			
	038GGI0901	1994	26700.00			
	038GGS0101	1994	21800.00			
	038GGS0201	1994	29600.00			
	038GGS0301	1994	37800.00			
	038GGS0401	1994	45900.00			
	038GGS0501	1994	52700.00			
	038GGS0601	1994	43000.00			
	038GGS0701	1994	27400.00			
	038GGS0801	1994	66100.00			
	038GGS0901	1994	24500.00			
	038GGS1001	1994	44800.00			
	038GGS1101	1994	9190.00			
	038GGS1201	1994	70800.00			
	038GGS1301	1994	32500.00			
	038GGS1401	1994	40300.00			
	038GGS1501	1994	32300.00			
	038GGS1601	1994	48900.00			
	038GGS1701	1994	29100.00			
	038GGS1801	1994	44700.00			
	038GGS1901	1994	26200.00			
	038GGS2001	1994	45600.00			
	038GGS2101	1994	43800.00			
	038G0I0401	1995	36000.00			
	038G0I0701	1995	41000.00			
	038G0I0801	1995	32000.00			
	038G0I0901	1995	32000.00			
	038G0I1001	1995	12000.00			
	038G0S0701	1995	38000.00			
	038G0S0901	1995	39000.00			
	038G0S1701	1995	31000.00			
	038G0S1801	1995	60000.00			
	038G0S2201	1995	33000.00			
	038G0S2301	1995	75000.00			
	038G0S2401	1995	61000.00			
	038G0S2501	1995	28000.00			
	038G0S2601	1995	49000.00			
	038G0S2701	1995	23000.00			
	038G0S2801	1995	16000.00			
	038G0S2901	1995	27000.00			
	038G0S3001	1995	13000.00			
	038G0S3101	1995	14000.00			
	038G0S3201	1995	43000.00			
	038G0T0501	1995	18000.00			
	038GS01	1998	49400.00			
	038GS03	1998	54100.00			
	038GS08	1998	74400.00			
	038GS12	1998	42900.00			
	038GS19	1998	46500.00			
	038GS28	1998	27500.00			
	038GS32	1998	49900.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
CHROMIUM (TOTAL)				100	NA	1000
	036GR73C01	1993	19.30			
	036GR74C01	1993	20.90			
	036GR75C01	1993	81.10			
	036GR76C01	1993	472.00	X		
	036GR77C01	1993	156.00	X		
	036GR78C01	1993	5.20 J			
	036GR79C01	1993	19.80			
	036GR80C01	1993	24.90			
	036GR81C01	1993	6.40 J			
	038GGI0101	1994	4.00			
	038GGI0201	1994	11.00 J			
	038GGI0301	1994	70.60			
	038GGI0401	1994	370.00	X		
	038GGI0701	1994	6.20			
	038GGI0901	1994	5.40			
	038GGS0101	1994	18.80			
	038GGS0201	1994	11.10			
	038GGS0301	1994	74.80			
	038GGS0601	1994	4.00			
	038GGS0801	1994	233.00	X		
	038GGS0901	1994	23.50			
	038GGS1001	1994	30.00			
	038GGS1101	1994	22.80			
	038GGS1201	1994	326.00	X		
	038GGS1301	1994	184.00	X		
	038GGS1401	1994	77.60			
	038GGS1501	1994	31.80			
	038GGS1601	1994	15.20			
	038GGS1701	1994	74.50			
	038GGS1801	1994	23.20			
	038GGS1901	1994	544.00	X		
	038GGS2001	1994	378.00	X		
	038GGS2101	1994	297.00	X		
	038G011001	1995	55.00			
	038G0S1701	1995	4.40			
	038G0S2201	1995	22.00			
	038G0S2901	1995	7.60			
	038G0T0501	1995	87.00			
	038GS08	1998	100.00			
	038GS19	1998	20.00			
COBALT				420	NA	4200
	036GR76C01	1993	2.00 J			
	038GGI0401	1994	4.30			
	038GGS0101	1994	3.70			
	038GGS0201	1994	5.10			
	038GGS0301	1994	3.70			
	038GGS0501	1994	3.00			
	038GGS1201	1994	3.60			
	038GGS2001	1994	3.20			
	038G0S3001	1995	3.20			
	038GS01	1998	20.00			
	038GS08	1998	20.00			
	038GS12	1998	20.00			
	038GS19	1998	20.00			
	038GS28	1998	20.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
				1000	2.9	10000
COPPER						
	036GR73C01	1993	35.90			X
	036GR74C01	1993	44.70			X
	036GR75C01	1993	44.60			X
	036GR76C01	1993	216.00			X
	036GR77C01	1993	195.00			X
	036GR78C01	1993	10.70 J			X
	036GR79C01	1993	60.90			X
	036GR80C01	1993	62.30			X
	036GR81C01	1993	17.10 J			X
	038GGI0101	1994	6.10			X
	038GGI0201	1994	12.50			X
	038GGI0301	1994	8.50			X
	038GGI0401	1994	26.90			X
	038GGI0701	1994	6.10			X
	038GGI0801	1994	4.60			X
	038GGI0901	1994	8.50			X
	038GGS0101	1994	91.10			X
	038GGS0201	1994	311.00			X
	038GGS0301	1994	45.60			X
	038GGS0401	1994	12.00			X
	038GGS0501	1994	32.40			X
	038GGS0601	1994	6.10			X
	038GGS0701	1994	5.70			X
	038GGS0801	1994	171.00			X
	038GGS0901	1994	288.00			X
	038GGS1001	1994	70.00			X
	038GGS1101	1994	17.60			X
	038GGS1201	1994	100.00			X
	038GGS1301	1994	319.00			X
	038GGS1401	1994	219.00			X
	038GGS1501	1994	28.50			X
	038GGS1601	1994	37.30			X
	038GGS1701	1994	9.10			X
	038GGS1801	1994	222.00			X
	038GGS1901	1994	195.00			X
	038GGS2001	1994	76.10			X
	038GGS2101	1994	389.00			X
	038G0S1801	1995	5.30			X
	038G0S2501	1995	8.20			X
	038G0S2801	1995	4.10			X
	038G0S2901	1995	26.00			X
	038G0S3001	1995	3.70			X
	038GS01	1998	30.00			X
	038GS08	1998	250.00			X
	038GS12	1998	910.00			X
	038GS19	1998	90.00			X
	038GS28	1998	30.00			X
	038GS32	1998	20.00			X
Cyanide (CN)				200	1	2000
	036GR73C01	1993	2.10 J			X
	036GR75C01	1993	9.90			X
	036GR76C01	1993	18.80			X
	036GR77C01	1993	11.90			X
	038G0S2901	1995	17.00 A			X

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
IRON			NOTE: Fe RC = 1707.8	300	300	3000
	036GR73C01	1993	11800.00	X	X	X
	036GR74C01	1993	2130.00	X	X	
	036GR75C01	1993	584.00	X	X	
	036GR76C01	1993	7510.00	X	X	X
	036GR77C01	1993	4210.00	X	X	X
	036GR78C01	1993	2170.00	X	X	
	036GR79C01	1993	7840.00	X	X	X
	036GR80C01	1993	8450.00	X	X	X
	036GR81C01	1993	980.00	X	X	
	038GGI0101	1994	3490.00 J	X	X	X
	038GGI0201	1994	1570.00 J	X	X	
	038GGI0301	1994	1250.00 J	X	X	
	038GGI0701	1994	646.00	X	X	
	038GGI0801	1994	235.00			
	038GGI0901	1994	410.00	X	X	
	038GGS0101	1994	6820.00	X	X	X
	038GGS0201	1994	7470.00	X	X	X
	038GGS0301	1994	4930.00	X	X	X
	038GGS0401	1994	1400.00	X	X	
	038GGS0601	1994	949.00	X	X	
	038GGS0701	1994	484.00	X	X	
	038GGS0801	1994	496.00	X	X	
	038GGS0901	1994	4660.00	X	X	X
	038GGS1001	1994	15700.00	X	X	X
	038GGS1101	1994	895.00	X	X	
	038GGS1201	1994	17600.00	X	X	X
	038GGS1301	1994	4560.00	X	X	X
	038GGS1401	1994	1160.00	X	X	
	038GGS1501	1994	135.00			
	038GGS1601	1994	1320.00	X	X	
	038GGS1701	1994	267.00			
	038GGS1801	1994	1170.00	X	X	
	038GGS1901	1994	2650.00	X	X	
	038GGS2001	1994	24900.00	X	X	X
	038GGS2101	1994	4520.00	X	X	X
	038G0I0401	1995	50.00			
	038G0I0701	1995	380.00	X	X	
	038G0I0801	1995	50.00			
	038G0I1001	1995	1200.00	X	X	
	038G0S0701	1995	100.00			
	038G0S0901	1995	280.00			
	038G0S1701	1995	40.00			
	038G0S2201	1995	90.00			
	038G0S2401	1995	3200.00	X	X	X
	038G0S2501	1995	130.00			
	038G0S2601	1995	230.00			
	038G0S2701	1995	240.00			
	038G0S2801	1995	100.00			
	038G0S2901	1995	610.00	X	X	
	038G0S3001	1995	380.00	X	X	
	038G0S3101	1995	180.00			
	038G0S3201	1995	40.00			
	038G0T0501	1995	1800.00	X	X	
	038GS01	1998	1240.00	X	X	
	038GS03	1998	160.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
NOTE: Fe RC = 1707.8				300	300	3000
IRON						
	038GS08	1998	120.00			
	038GS12	1998	1150.00	X	X	
	038GS19	1998	53.00			
	038GS28	1998	380.00	X	X	
	038GS32	1998	1100.00	X	X	
LEAD				15	5.6	150
	036GR73C01	1993	265.00	X	X	X
	036GR74C01	1993	367.00	X	X	X
	036GR75C01	1993	39.80	X	X	
	036GR76C01	1993	374.00	X	X	X
	036GR77C01	1993	47.20	X	X	
	036GR78C01	1993	20.30	X	X	
	036GR79C01	1993	51.70	X	X	
	036GR80C01	1993	220.00	X	X	X
	036GR81C01	1993	48.90	X	X	
	038GGI0101	1994	4.40 J			
	038GGI0201	1994	3.60 J			
	038GGI0401	1994	13.60		X	
	038GGI0701	1994	2.70			
	038GGI0901	1994	3.80			
	038GGS0101	1994	276.00	X	X	X
	038GGS0201	1994	362.00 J	X	X	X
	038GGS0301	1994	88.50	X	X	
	038GGS0401	1994	14.00		X	
	038GGS0501	1994	55.80	X	X	
	038GGS0701	1994	18.60	X	X	
	038GGS0801	1994	79.20	X	X	
	038GGS0901	1994	58.80	X	X	
	038GGS1001	1994	54.00	X	X	
	038GGS1101	1994	20.10	X	X	
	038GGS1201	1994	280.00	X	X	X
	038GGS1301	1994	158.00	X	X	X
	038GGS1401	1994	118.00	X	X	
	038GGS1501	1994	52.00	X	X	
	038GGS1601	1994	11.00 J		X	
	038GGS1701	1994	65.20	X	X	
	038GGS1801	1994	71.20 J	X	X	
	038GGS1901	1994	180.00	X	X	X
	038GGS2001	1994	110.00	X	X	
	038GGS2101	1994	639.00	X	X	X
	038G0S1801	1995	3.30			
	038G0S2301	1995	5.60			
	038G0T0501	1995	2.80			
	038GS01	1998	117.00	X	X	
	038GS08	1998	116.00	X	X	
	038GS12	1998	128.00	X	X	
	038GS19	1998	58.00	X	X	
	038GS28	1998	4.00			
	038GS32	1998	24.00	X	X	
MAGNESIUM				NOT AVAILABLE		
	036GR73C01	1993	4350.00 J			
	036GR74C01	1993	4150.00 J			
	036GR75C01	1993	3320.00 J			
	036GR76C01	1993	3600.00 J			
	036GR77C01	1993	4150.00 J			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
MAGNESIUM				NOT AVAILABLE		
	036GR78C01	1993	10500.00			
	036GR79C01	1993	5040.00			
	036GR80C01	1993	3160.00 J			
	036GR81C01	1993	3410.00 J			
	038GGI0101	1994	11900.00 J			
	038GGI0201	1994	117000.00 J			
	038GGI0301	1994	27600.00 J			
	038GGI0401	1994	13000.00			
	038GGI0701	1994	28400.00			
	038GGI0801	1994	11000.00			
	038GGI0901	1994	15700.00			
	038GGS0101	1994	2150.00			
	038GGS0201	1994	4990.00			
	038GGS0301	1994	3880.00			
	038GGS0401	1994	3990.00			
	038GGS0501	1994	180.00			
	038GGS0601	1994	3290.00			
	038GGS0701	1994	2070.00			
	038GGS0801	1994	3740.00			
	038GGS0901	1994	2030.00			
	038GGS1001	1994	5480.00			
	038GGS1101	1994	1260.00			
	038GGS1201	1994	7510.00			
	038GGS1301	1994	2890.00			
	038GGS1401	1994	2980.00			
	038GGS1501	1994	3530.00			
	038GGS1601	1994	6080.00			
	038GGS1701	1994	3200.00			
	038GGS1801	1994	4140.00			
	038GGS1901	1994	4130.00			
	038GGS2001	1994	4360.00			
	038GGS2101	1994	3800.00			
	038G0I0401	1995	9300.00			
	038G0I0701	1995	32000.00			
	038G0I0801	1995	11000.00			
	038G0I0901	1995	26000.00			
	038G0I1001	1995	16000.00			
	038G0S0701	1995	2900.00			
	038G0S0901	1995	2400.00			
	038G0S1701	1995	2500.00			
	038G0S1801	1995	5200.00			
	038G0S2201	1995	2600.00			
	038G0S2301	1995	180000.00			
	038G0S2401	1995	3400.00			
	038G0S2501	1995	2000.00			
	038G0S2601	1995	21000.00			
	038G0S2701	1995	3800.00			
	038G0S2801	1995	1800.00			
	038G0S2901	1995	2800.00			
	038G0S3001	1995	1100.00			
	038G0S3101	1995	910.00			
	038G0S3201	1995	3500.00			
	038G0T0501	1995	24000.00			
	038GS01	1998	7480.00			
	038GS03	1998	13700.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
MAGNESIUM				NOT AVAILABLE		
	038GS08	1998	5020.00			
	038GS12	1998	15300.00			
	038GS19	1998	4730.00			
	038GS28	1998	2250.00			
	038GS32	1998	3450.00			
MANGANESE				50	NA	500
	036GR73C01	1993	61.40	X		
	036GR74C01	1993	28.40			
	036GR75C01	1993	52.60	X		
	036GR76C01	1993	132.00	X		
	036GR77C01	1993	77.60	X		
	036GR78C01	1993	48.30	X		
	036GR79C01	1993	217.00	X		
	036GR80C01	1993	98.70	X		
	036GR81C01	1993	57.20	X		
	038GGI0101	1994	43.10 J			
	038GGI0201	1994	38.00 J			
	038GGI0301	1994	28.40 J			
	038GGI0401	1994	140.00	X		
	038GGI0701	1994	48.00			
	038GGI0801	1994	19.30			
	038GGI0901	1994	17.30			
	038GGS0101	1994	174.00	X		
	038GGS0201	1994	26.50			
	038GGS0301	1994	40.60			
	038GGS0401	1994	41.00			
	038GGS0601	1994	97.80	X		
	038GGS0701	1994	11.90			
	038GGS0801	1994	194.00	X		
	038GGS0901	1994	33.20			
	038GGS1001	1994	101.00	X		
	038GGS1101	1994	16.70			
	038GGS1201	1994	128.00	X		
	038GGS1901	1994	155.00	X		
	038GGS2001	1994	98.10			
	038GGS2101	1994	104.00	X		
	038G0I0401	1995	24.00			
	038G0I0701	1995	14.00			
	038G0I0801	1995	6.20			
	038G0I0901	1995	16.00			
	038G0I1001	1995	30.00			
	038G0S0701	1995	24.00			
	038G0S0901	1995	24.00			
	038G0S1701	1995	33.00			
	038G0S1801	1995	15.00			
	038G0S2301	1995	23.00			
	038G0S2401	1995	27.00			
	038G0S2501	1995	5.30			
	038G0S2601	1995	120.00	X		
	038G0S2701	1995	4.80			
	038G0S2801	1995	7.80			
	038G0S2901	1995	130.00	X		
	038G0S3001	1995	5.90			
	038G0S3201	1995	26.00			
	038G0T0501	1995	20.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
MANGANESE				50	NA	500
	038GS03	1998	50.00			
	038GS08	1998	1990.00	X		X
	038GS12	1998	40.00			
	038GS19	1998	950.00	X		X
MERCURY				2	0.012	20
	036GR73C01	1993	0.28		X	
	036GR74C01	1993	0.28		X	
	036GR76C01	1993	1.00		X	
	038GGI0401	1994	0.20		X	
	038GGS0701	1994	1.00 J		X	
	038GGS0801	1994	0.67 J		X	
	038GGS0901	1994	0.31 J		X	
	038GGS1001	1994	0.33		X	
	038GS08	1998	0.20		X	
	038GS19	1998	0.30		X	
MOLYBDENUM				35	NA	350
	038G011001	1995	22.00			
	038G0S2901	1995	2.30			
	038G0T0501	1995	31.00			
NICKEL				100	8.3	1000
	036GR76C01	1993	46.60		X	
	036GR77C01	1993	11.60 J		X	
	038GGS0501	1994	15.90		X	
	038GGS1001	1994	10.00		X	
	038GGS2001	1994	16.00		X	
	038G0S2401	1995	12.00		X	
	038G0S2901	1995	4.30			
	038G0S3001	1995	4.00			
	038GS01	1998	20.00		X	
	038GS03	1998	20.00		X	
	038GS08	1998	30.00		X	
	038GS12	1998	30.00		X	
	038GS28	1998	30.00		X	
POTASSIUM				NOT AVAILABLE		
	036GR73C01	1993	6530.00			
	036GR74C01	1993	4240.00 J			
	036GR75C01	1993	4070.00 J			
	036GR76C01	1993	8650.00			
	036GR77C01	1993	2340.00 J			
	036GR78C01	1993	4360.00 J			
	036GR79C01	1993	2570.00 J			
	036GR80C01	1993	2750.00 J			
	036GR81C01	1993	3120.00 J			
	038GGI0101	1994	8880.00 J			
	038GGI0201	1994	72800.00 J			
	038GGI0301	1994	39400.00 J			
	038GGI0401	1994	6220.00			
	038GGI0701	1994	20500.00			
	038GGI0801	1994	10500.00			
	038GGI0901	1994	9000.00			
	038GGS0101	1994	2690.00			
	038GGS0201	1994	2990.00			
	038GGS0301	1994	4270.00			
	038GGS0401	1994	2240.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
POTASSIUM				NOT AVAILABLE		
	038GGS0601	1994	2990.00			
	038GGS0701	1994	3170.00			
	038GGS0801	1994	3850.00			
	038GGS0901	1994	2750.00			
	038GGS1001	1994	2410.00			
	038GGS1101	1994	1470.00			
	038GGS1201	1994	7850.00			
	038GGS1301	1994	2830.00			
	038GGS1401	1994	6410.00			
	038GGS1501	1994	5940.00			
	038GGS1601	1994	4920.00 J			
	038GGS1701	1994	2290.00 J			
	038GGS1801	1994	6950.00			
	038GGS1901	1994	2950.00			
	038GGS2001	1994	2840.00			
	038GGS2101	1994	2640.00			
	038G0I0401	1995	5200.00			
	038G0I0701	1995	24000.00			
	038G0I0801	1995	11000.00			
	038G0I0901	1995	12000.00			
	038G0I1001	1995	21000.00			
	038G0S0701	1995	3500.00			
	038G0S0901	1995	2200.00			
	038G0S1701	1995	1600.00			
	038G0S1801	1995	6400.00			
	038G0S2201	1995	4700.00			
	038G0S2301	1995	80000.00			
	038G0S2401	1995	3000.00			
	038G0S2501	1995	1200.00			
	038G0S2601	1995	2300.00			
	038G0S2701	1995	1800.00			
	038G0S2801	1995	1400.00			
	038G0S2901	1995	5600.00			
	038G0S3001	1995	890.00			
	038G0S3201	1995	2800.00			
	038G0T0501	1995	36000.00			
	038GS01	1998	4020.00			
	038GS03	1998	6820.00			
	038GS08	1998	3020.00			
	038GS12	1998	8210.00			
	038GS19	1998	5200.00			
	038GS28	1998	1410.00			
	038GS32	1998	3930.00			
SELENIUM				-	50	71 500
	036GR74C01	1993	2.20 J			
	036GR76C01	1993	3.10 J			
	036GR78C01	1993	1.40 J			
	036GR79C01	1993	1.40 J			
	036GR81C01	1993	2.20 J			
	038GGI0201	1994	3.20 J			
	038GGI0401	1994	2.00			
	038GGI0901	1994	2.10			
	038GGS0501	1994	2.00			
	038GGS1001	1994	2.00			
	038GGS1201	1994	5.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
SODIUM				160000	NA	1600000
	036GR73C01	1993	7090.00			
	036GR74C01	1993	12800.00			
	036GR75C01	1993	9940.00			
	036GR76C01	1993	21900.00			
	036GR77C01	1993	5790.00			
	036GR78C01	1993	9400.00			
	036GR79C01	1993	11300.00			
	036GR80C01	1993	12300.00			
	036GR81C01	1993	8060.00			
	038GGI0101	1994	48100.00 J			
	038GGI0201	1994	136000.00 J			
	038GGI0301	1994	538000.00 J		X	
	038GGI0701	1994	219000.00		X	
	038GGI0801	1994	80300.00			
	038GGI0901	1994	10300.00			
	038GGS0101	1994	7920.00			
	038GGS0201	1994	11100.00			
	038GGS0301	1994	21800.00			
	038GGS0401	1994	5880.00			
	038GGS0501	1994	12600.00			
	038GGS0601	1994	6250.00			
	038GGS0701	1994	7900.00			
	038GGS0801	1994	10000.00			
	038GGS0901	1994	14900.00			
	038GGS1001	1994	622.00			
	038GGS1101	1994	10500.00			
	038GGS1201	1994	17600.00			
	038GGS1301	1994	9390.00			
	038GGS1401	1994	7540.00			
	038GGS1501	1994	13200.00			
	038GGS1601	1994	7730.00			
	038GGS1701	1994	10700.00			
	038GGS1801	1994	11100.00			
	038GGS1901	1994	11700.00			
	038GGS2001	1994	6820.00			
	038GGS2101	1994	5510.00			
	038G0I0401	1995	37000.00			
	038G0I0701	1995	270000.00		X	
	038G0I0801	1995	85000.00			
	038G0I0901	1995	200000.00		X	
	038G0I1001	1995	350000.00		X	
	038G0S0701	1995	5900.00			
	038G0S0901	1995	6900.00			
	038G0S1701	1995	4300.00			
	038G0S1801	1995	11000.00			
	038G0S2201	1995	12000.00			
	038G0S2301	1995	2000000.00		X	
	038G0S2401	1995	11000.00			
	038G0S2501	1995	13000.00			
	038G0S2601	1995	9300.00			
	038G0S2701	1995	35000.00			
	038G0S2801	1995	13000.00			
	038G0S2901	1995	11000.00			
	038G0S3001	1995	14000.00			
	038G0S3101	1995	6400.00			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
SODIUM				160000	NA	1600000
	038G0S3201	1995	7000.00	X		
	038G0T0501	1995	600000.00			
	038GS01	1998	31200.00			
	038GS03	1998	90800.00			
	038GS08	1998	28400.00			
	038GS12	1998	83700.00			
	038GS19	1998	20000.00			
	038GS28	1998	13800.00			
	038GS32	1998	24700.00			
STRONTIUM				4200	NA	42000
	038G0I0401	1995	240.00			
	038G0I0701	1995	430.00			
	038G0I0801	1995	240.00			
	038G0I0901	1995	270.00			
	038G0I1001	1995	140.00			
	038G0S0701	1995	130.00			
	038G0S0901	1995	150.00			
	038G0S1701	1995	110.00			
	038G0S1801	1995	230.00			
	038G0S2201	1995	130.00			
	038G0S2301	1995	1100.00			
	038G0S2401	1995	220.00			
	038G0S2501	1995	92.00			
	038G0S2601	1995	180.00			
	038G0S2701	1995	62.00			
	038G0S2801	1995	48.00			
	038G0S2901	1995	140.00			
	038G0S3001	1995	59.00			
	038G0S3101	1995	84.00			
	038G0S3201	1995	140.00			
	038G0T0501	1995	200.00			
THALLIUM				2	6.3	20
	038GGI0401	1994	2.00			
	038GGS1001	1994	2.00			
TITANIUM				NOT AVAILABLE		
	038G0I1001	1995	97.00			
	038G0S2301	1995	14.00			
	038G0S2501	1995	2.60			
	038G0S2701	1995	2.50			
	038G0S2801	1995	2.20			
	038G0S3001	1995	2.40			
	038G0T0501	1995	140.00			
VANADIUM				49	NA	490
	036GR73C01	1993	34.40 J	X		
	036GR76C01	1993	15.80 J			
	036GR77C01	1993	3.60 J			
	036GR79C01	1993	12.40 J			
	036GR80C01	1993	19.20 J			
	036GR81C01	1993	4.70 J			
	038GGI0101	1994	5.50			
	038GGI0201	1994	13.80			
	038GGI0301	1994	222.00 J			
	038GGI0701	1994	3.10			
	038GGI0901	1994	5.10			

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
VANADIUM				49	NA	490
	038GGS0101	1994	15.90			
	038GGS0201	1994	9.80			
	038GGS0301	1994	12.00			
	038GGS0401	1994	3.00			
	038GGS0501	1994	12.90			
	038GGS0601	1994	4.40			
	038GGS0801	1994	5.30			
	038GGS0901	1994	4.50			
	038GGS1001	1994	33.00			
	038GGS1201	1994	74.60	X		
	038GGS1301	1994	11.70			
	038GGS1401	1994	3.60			
	038GGS1901	1994	5.70			
	038GGS2001	1994	65.80	X		
	038GGS2101	1994	7.90			
	038G011001	1995	140.00	X		
	038G0S2301	1995	19.00			
	038G0S2701	1995	3.50			
	038G0S2801	1995	5.60			
	038G0S3201	1995	6.50			
	038G0T0501	1995	230.00	X		
YTTRIUM				NOT AVAILABLE		
	038G011001	1995	23.00			
	038G0T0501	1995	52.00			
ZINC				5000	86	50000
	036GR73C01	1993	70.50			
	036GR74C01	1993	127.00		X	
	036GR75C01	1993	55.00			
	036GR76C01	1993	290.00		X	
	036GR77C01	1993	54.70			
	036GR78C01	1993	32.10			
	036GR79C01	1993	261.00		X	
	036GR80C01	1993	158.00		X	
	036GR81C01	1993	24.30			
	038GGI0101	1994	16.00			
	038GGI0201	1994	142.00 J		X	
	038GGI0301	1994	17.00			
	038GGI0401	1994	97.60		X	
	038GGI0701	1994	10.80			
	038GGI0801	1994	6.60			
	038GGI0901	1994	15.40			
	038GGS0101	1994	668.00		X	
	038GGS0201	1994	133.00		X	
	038GGS0301	1994	819.00		X	
	038GGS0401	1994	12.00			
	038GGS0501	1994	527.00		X	
	038GGS0601	1994	206.00		X	
	038GGS0701	1994	71.70			
	038GGS0801	1994	123.00		X	
	038GGS0901	1994	222.00		X	
	038GGS1001	1994	52.00			
	038GGS1101	1994	46.90			
	038GGS1201	1994	1230.00		X	
	038GGS1301	1994	684.00		X	
	038GGS1401	1994	364.00		X	

SITE 38 GROUNDWATER DATA
INORGANICS (UNITS ARE UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
ZINC				5000	86	50000
	038GGS1501	1994	168.00			X
	038GGS1601	1994	349.00			X
	038GGS1701	1994	22.40			
	038GGS1801	1994	325.00			X
	038GGS1901	1994	367.00			X
	038GGS2001	1994	145.00			X
	038GGS2101	1994	804.00			X
	038G0I1001	1995	5.60			
	038G0S0701	1995	26.00			
	038G0S0901	1995	39.00			
	038G0S1801	1995	620.00			X
	038G0S2201	1995	21.00			
	038G0S2401	1995	26.00			
	038G0S2501	1995	98.00			X
	038G0S2601	1995	24.00			
	038G0S2701	1995	82.00			
	038G0S2801	1995	66.00			
	038G0S2901	1995	19.00			
	038G0S3001	1995	43.00			
	038G0S3101	1995	320.00			X
	038G0S3201	1995	36.00			
	038GS01	1998	570.00			X
	038GS03	1998	530.00			X
	038GS08	1998	650.00			X
	038GS12	1998	950.00			X
	038GS19	1998	200.00			X
	038GS28	1998	190.00			X
	038GS32	1998	150.00			X

SITE 38 GROUNDWATER DATA

SEMIVOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
1,2,4-TRIMETHYLBENZENE				10	217.5	100
	038GS12	1998	23.00	X		
1,2-DICHLOROBENZENE				600	99	6000
	038GGS0201	1994	5.00 J			
	038GGS1201	1994	9.00 J			
	038GS12	1998	4.00			
1,3,5-TRIMETHYLBENZENE				10	215	100
	038GS12	1998	12.00	X		
1,4-DICHLOROBENZENE				75	100	750
	038GS12	1998	2.00			
2,4-DIMETHYLPHENOL				140	261	1400
	038GGS1201	1994	2.00 J			
2,4-DINITROTOLUENE				0.1	9.1	1
	038GGS1801	1994	2.00 J	X		X
2-METHYLNAPHTHALENE				20	30	200
	038G0S1701	1995	14.00			
	038GGS0201	1994	14.00			
	038GGS1201	1994	10.00 J			
	038GGS1301	1994	2.00 J			
	038GGS1501	1994	5.00 J			
	038GGS1701	1994	14.00			
	038GGS1801	1994	1.00 J			
	038GGS2001	1994	4.00 J			
4-METHYLPHENOL (p-Cresol)				4	70	40
	038GGS1201	1994	1.00 J			
ACENAPHTHENE				20	3	200
	038G0S1801	1995	1.80 J			
	038GGS0201	1994	1.00 J			
	038GGS1801	1994	4.00 J		X	
ANTRHACENE				2100	0.3	21000
	038GGS1801	1994	17.00		X	
BENZO(A)ANTHRACENE				0.2	0.031	2
	036GR77C01	1993	8.00 J	X	X	X
BENZO(A)PYRENE				0.2	0.031	2
	036GR77C01	1993	7.00 J	X	X	X
BENZO(B)FLUORANTHENE				0.2	0.031	2
	036GR77C01	1993	6.00 J	X	X	X
BENZO(K)FLUORANTHENE				0.5	0.031	5
	036GR77C01	1993	6.00 J	X	X	X

SITE 38 GROUNDWATER DATA

SEMIVOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
bis(2-Ethylhexyl)phthalate (BEHP)				6	0.02	60
	038G0S0901	1995	11.00	X	X	
	038G0S3201	1995	22.00	X	X	
	038GGI0101	1994	3.00 J		X	
	038GGI0201	1994	1.00 J		X	
	038GGI0301	1994	1.00 J		X	
CARBAZOLE				4	46.5	40
	038GGS1801	1994	2.00 J			
CHRYSENE				4.8	0.031	48
	036GR77C01	1993	7.00 J	X	X	
DIBENZOFURAN				28	67	280
	038GGS1801	1994	14.00			
FLUORANTHENE				280	0.3	2800
	036GR77C01	1993	19.00 J		X	
	038G0S1801	1995	7.00 J		X	
	038GGS1801	1994	23.00		X	
NAPHTHALENE				20	26	200
	038G0S1701	1995	24.00	X		
	038G0T0501	1995	1.40 J			
	038GGS0201	1994	44.00	X	X	
	038GGS1201	1994	44.00	X	X	
	038GGS1501	1994	140.00 J	X	X	
	038GGS1701	1994	15.00			
	038GGS2001	1994	7.00 J			
	038GS12	1998	12.00			
PHENANTHRENE				210	0.031	2100
	036GR77C01	1993	10.00 J		X	
	038G0T0501	1995	3.70 J		X	
	038GGS1801	1994	170.00 J		X	
PHENOL				10	6.5	100
	038GGI0201	1994	9.00 J		X	
PYRENE				210	0.3	2100
	036GR77C01	1993	15.00 J		X	
	038G0S1801	1995	8.80 J		X	
	038GGS1801	1994	11.00		X	

SITE 38 GROUNDWATER DATA

VOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
1,1,1,2-TETRACHLOROETHANE					1.3	NA 13
	038GS19	1998	22.0		X	X
1,1,1-TRICHLOROETHANE					200	270 2000
	036GR76C01	1993	4.0 J			
	038GGS0501	1994	24.0			
	038GGS0801	1994	4.0 J			
	038GGS1101	1994	2.0 J			
	038GGS1201	1994	770.0 J		X	
	038GGS1301	1994	8.0 J			
	038GGS1401	1994	16.0			
	038GGS1701	1994	3.0 J			
	038GGS1801	1994	6.0 J			
	038G011001	1995	0.6 J			
	038G0S0901	1995	0.9 AJ			
	038G0S1801	1995	1.0 J			
	038G0S2201	1995	8.8 A			
	038G0T0501	1995	2.4 J			
	038GS12	1998	3.0			
1,1,2,2-TETRACHLOROETHANE					0.2	10.8 20
	038GS12	1998	100.0		X	X
1,1-DICHLOROETHANE					70	NA 700
	036GR76C01	1993	7.0 J			
	038GGS0201	1994	44.0			
	038GGS0501	1994	12.0			
	038GGS0701	1994	3.0 J			
	038GGS1201	1994	640.0 J		X	
	038GGS1301	1994	20.0			
	038GGS1401	1994	5.0 J			
	038GGS1501	1994	180.0 DJ		X	
	038GGS1601	1994	4.0 J			
	038GGS1701	1994	6.0 J			
	038GGS1801	1994	4.0 J			
	038G0S0701	1995	0.7 AJ			
	038G0S1801	1995	1.1 J			
	038G0S2201	1995	32.0 A			
	038G0S2301	1995	9.8 A			
	038G0T0501	1995	1.2 J			
	038GS03	1998	3.0			
	038GS12	1998	13.0			
1,1-DICHLOROETHENE					7	3.2 70
	038GGS1201	1994	42.0		X	X
	038GGS1401	1994	5.0 J-			X
	038GGS1501	1994	2.0 J			
	038GGS1801	1994	4.0 J			X
	038G0S1701	1995	21.0 J		X	X
	038G0S1801	1995	0.7 J			
	038G0S2201	1995	1.3 AJ			
1,2-DICHLOROETHANE					3	5 30
	036GR75C01	1993	70.0		X	X
	036GR76C01	1993	19.0		X	X
	038GGS1201	1994	2.0 J			

SITE 38 GROUNDWATER DATA

VOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
1,2-DICHLOROETHENE (total)					63	7000 630
	038GGS0201	1994	2.0 J			
	038GGS0301	1994	2.0 J			
	038GGS0701	1994	22.0			
	038GGS0801	1994	36.0			
	038GGS0901	1994	49.0			
	038GGS1201	1994	14.0			
	038GGS1401	1994	8.0 J			
	038GGS1501	1994	14.0			
	038GGS1601	1994	2.0 J			
	038GGS1801	1994	6.0 J			
	038GGS1901	1994	130.0 J	X		
	038GGS2001	1994	970.0 D	X		X
	038GGS2101	1994	100.0 J	X		
2-BUTANONE (MEK)					4200	120000 42000
	038GGI0301	1994	34.0 J			
	038GGS1801	1994	8.0 J			
	038GGS2001	1994	150.0			
ACETONE					700	1692 7000
	038GGI0301	1994	7.0 J			
	038GGI0401	1994	6.0 J			
	038GGI0701	1994	15.0 J			
	038GGI0901	1994	500.0 J			
	038GGS2001	1994	9.0 J			
BENZENE					1	71.28 10
	038GS03	1998	2.0	X		
BROMOMETHANE					9.8	35 98
	038GGI0301	1994	3.0 J			
CARBON DISULFIDE					700	105 7000
	038GGI0801	1994	2.0 J			
CHLOROBENZENE					100	17 1000
	038GGS0201	1994	4.0 J			
	038G0S2301	1995	5.2 A			
CHLOROETHANE (ETHYL CHLORIDE)					12	NA 120
	038GGS0201	1994	8.0 J			
	038GGS1501	1994	3.0 J			
	038GGS0203	1999	13.0	X		
CHLOROFORM					5.7	470.8 57
	038GGS1101	1994	6.0 J	X		
	038GGS1201	1994	24.0	X		
	038G0S2801	1995	1.2 J			
	038GS12	1998	2.0			
CIS-1,2-DICHLOROETHENE					70	NA 700
	038GS03	1998	5.0			
	038GS08	1998	25.0			
	038GS12	1998	27.0			
	038GS19	1998	27.0			
	038GS29	1998	27.0			
	038GS32	1998	25.0			
	038G0S0701	1995	2.6 AJ			
	038G0S0901	1995	12.0 A			
	038G0S1701	1995	460.0		X	

SITE 38 GROUNDWATER DATA

VOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
CIS-1,2-DICHLOROETHENE					70	NA 700
	038G0S1801	1995	1.7 J			
	038G0S2201	1995	12.0 A			
	038G0S2401	1995	1.4 J			
	038G0S2901	1995	28.0 A			
	038G0S3001	1995	0.6 AJ			
	038G0S3201	1995	640.0	X		
ETHYLBENZENE					30	605 300
	038GGS0201	1994	22.0			
	038GGS1001	1994	3.0 J			
	038GGS1201	1994	1.0 J			
	038GGS1501	1994	89.0	X		
	038GGS1701	1994	2.0 J			
	038GGS0203	1999	14.0			
MTBE					50	33600 500
	038GS03	1998	16.0			
N-BUTYLBENZENE					NONE	
	038GS12	1998	5.0			
N-PROPYLBENZENE					NONE	
	038GS12	1998	1.0			
SEC-BUTYLBENZENE					NONE	
	038GS12	1998	4.0			
TETRACHLOROETHENE					3	8.85 30
	036GR74C01	1993	3.0 J			
	036GR75C01	1993	5.0 J	X		
	038GGS0501	1994	1.0 J			
	038GGS0801	1994	14.0	X	X	
	038GGS0901	1994	2.0 J			
	038GGS1201	1994	33.0 J	X	X	X
	038GGS1301	1994	3.0 J			
	038GGS1401	1994	20.0	X	X	
	038GGS1601	1994	1.0 J			
	038GGS1701	1994	4.0 J	X		
	038GGS1801	1994	41.0	X	X	X
	038GGS1901	1994	240.0	X	X	X
	038GGS2001	1994	14.0 J	X	X	
	038GGS2101	1994	280.0	X	X	X
	038G0I1001	1995	0.8 J			
	038G0S0901	1995	2.8 AJ			
	038G0S1701	1995	110.0	X	X	X
	038G0S1801	1995	10.0	X	X	
	038G0S2201	1995	7.0 A	X		
	038G0S2701	1995	1.0 J			
	038G0S2901	1995	1.0 AJ			
	038G0S3001	1995	1.5 AJ			
	038G0S3201	1995	820.0	X	X	X
	038G0T0501	1995	2.8 J			
	038GS08	1998	8.0	X		
	038GS12	1998	102.0	X	X	X
	038GS19	1998	22.0	X	X	
	038GS32	1998	5.0	X		

SITE 38 GROUNDWATER DATA

VOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
TOLUENE					40	475 400
	038GGS0201	1994	3.0 J			
	038GGS1701	1994	2.0 J			
TRANS-1,2-DICHLOROETHENE					100	11000 1000
	038G0S0701	1995	2.4 AJ			
	038G0S0901	1995	8.3 A			
	038G0S1701	1995	14.0 J			
	038G0S2201	1995	3.0 AJ			
	038G0S2301	1995	0.7 AJ			
	038G0S2401	1995	1.4 J			
	038G0S2901	1995	9.3 A			
	038G0S3201	1995	43.0 J			
	038GS08	1998	4.0			
	038GS19	1998	5.0			
	038GS32	1998	11.0			
TRICHLOROETHENE					3	80.7 30
	036GR75C01	1993	13.0	X		
	036GR76C01	1993	11.0	X		
	038GGS0301	1994	1.0 J			
	038GGS0501	1994	2.0 J			
	038GGS0801	1994	33.0	X		X
	038GGS0901	1994	6.0 J	X		
	038GGS1201	1994	53.0	X		X
	038GGS1301	1994	4.0 J	X		
	038GGS1401	1994	19.0	X		
	038GGS1601	1994	2.0 J			
	038GGS1801	1994	20.0	X		
	038GGS1901	1994	41.0	X		
	038GGS2101	1994	13.0 J	X		
	038G0S0901	1995	8.4	X		
	038G0S1701	1995	19.0 J	X		
	038G0S1801	1995	7.6	X		
	038G0S2201	1995	9.0 A	X		
	038G0S2401	1995	3.6 J	X		
	038G0S2901	1995	4.0 AJ	X		
	038G0S3201	1995	340.0	X	X	X
	038G0T0501	1995	2.0 J			
	038GS03	1998	4.0	X		
	038GS08	1998	24.0	X		
	038GS12	1998	25.0	X		
	038GS19	1998	22.0	X		
	038GS32	1998	5.0	X		
VINYL CHLORIDE					1	NA 10
	036GR75C01	1993	38.0	X		X
	036GR76C01	1993	21.0	X		X
	038GGS0201	1994	12.0 J	X		X
	038GGS0801	1994	6.0 J	X		
	038GGS0901	1994	12.0	X		X
	038GGS1301	1994	11.0 J	X		X
	038GGS1501	1994	41.0 J	X		X
	038GGS1701	1994	1600.0 D	X		X
	038GGS1901	1994	29.0	X		X
	038GGS2001	1994	1100.0 D	X		X

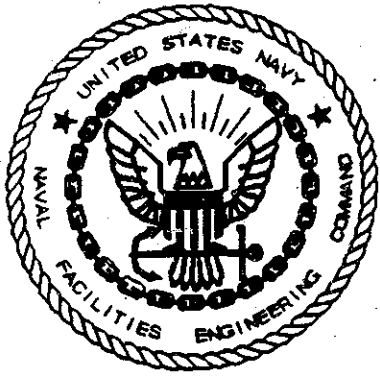
SITE 38 GROUNDWATER DATA
VOLATILE ORGANIC COMPOUNDS (UNITS IN UG/L)

PARAMETER	SAMPLE ID	DATE	RESULT	GC	MSWQ	PQG
VINYL CHLORIDE					1	NA 10
	038GGS2101	1994	15.0 J		X	X
	038G0I0401	1995	4.2		X	
	038G0I0801	1995	1.9		X	
	038G0I0901	1995	1.0 J			
	038G0S0701	1995	6.2		X	
	038G0S0901	1995	6.6		X	
	038G0S1701	1995	3700.0		X	X
	038G0S2201	1995	70.0		X	X
	038G0S2901	1995	43.0		X	X
	038G0S3201	1995	130.0		X	X
	038GS03	1998	3.0		X	
	038GS12	1998	15.0		X	X
	038GS19	1998	3.0		X	
	038GS32	1998	14.0		X	X
	038GGS2003	1999	15.0		X	X
XYLENE (TOTAL)					20	370 200
	038GGI0801	1994	1.0 J			
	038GGS0201	1994	3.0 J			
	038GGS0401	1994	3.0 J			
	038GGS1201	1994	2.0 J			
	038GGS1701	1994	8.0 J			
	038GGS2001	1994	11.0 J			

Appendix D
Draft MNA Memorandum

FINAL TECHNICAL MEMORANDUM

**EVALUATION OF MONITORED NATURAL
ATTENUATION**

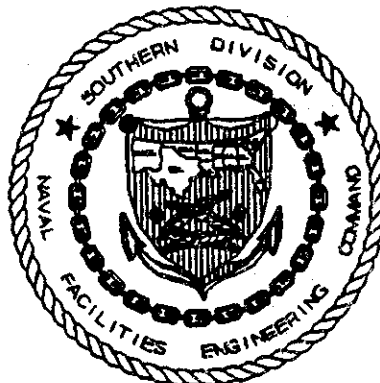


**SITE 38 (Buildings 71 and 604)
NAS PENSACOLA
PENSACOLA, FLORIDA**

**SOUTHNAVFACENGCOM
CONTRACT NO.: N62467-89-D0318
CTO-059**

Prepared for:

**Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina**



Prepared by:

**EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962**

December 6, 1999

FINAL TECHNICAL MEMORANDUM

EVALUATION OF MONITORED NATURAL ATTENUATION

SITE 38 (Buildings 71 and 604)
NAS PENSACOLA
PENSACOLA, FLORIDA

SOUTHNAVFACENGCOM
CONTRACT NO.: N62467-89-D0318
CTO-059

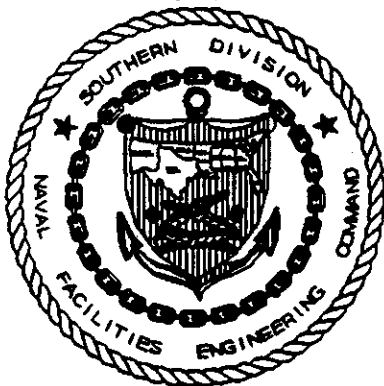


Prepared for:

Department of the Navy
Southern Division
Naval Facilities Engineering Command
North Charleston, South Carolina

Prepared by:

EnSafe Inc.
5724 Summer Trees Drive
Memphis, Tennessee 38134
(901) 372-7962



The Contractor, EnSafe Inc., hereby certifies that, to the best of its knowledge and belief, the technical data delivered herewith under Contract No. N62467-89-D-0318 are complete, accurate, and complies with all requirements of the contract.

Date: December 6, 1999
Signature: Allison Harris
Name: Allison Harris
Title: Task Order Manager

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Appendix A	Glossary of Terms
Appendix B	USEPA MNA Protocol
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1.0 INTRODUCTION

A natural attenuation study was performed as part of the feasibility study (FS) for Site 38 (Buildings 71 and 604) at the Naval Air Station (NAS) Pensacola. The primary focus of this study was to assess whether natural attenuation is occurring in groundwater and if it is a viable option for degrading volatile organic compounds (VOCs) to less harmful constituents. The impact of geochemical processes on detected inorganic compounds (specifically lead) in groundwater was also evaluated. This technical memorandum reviews the investigative process, evaluates the data, and presents the study results.

Information in this technical memorandum is referenced in the Site 38 Final FS Report to supplement the evaluation of remedial alternatives, and therefore this technical memorandum is to be used for information only. A glossary of monitored natural attenuation terms is provided in Appendix A. No effort has been made to formalize the document, nor has any background information on site history, geology, or previous investigations been included. Please refer to the following documents, prepared by EnSafe Inc. for additional information:

Site 38 Final Sampling and Analysis Plan (May 11, 1993)

Site 38 Final Remedial Investigation Report (September 5, 1997) with Baseline Risk Assessment Errata (September 30, 1998)

Site 38 Final Remedial Investigation Report Addendum (September 23, 1999).

2.0 DESCRIPTION OF MONITORED NATURAL ATTENUATION

Natural attenuation is the use of natural processes to contain the spread of contamination, reduce its concentration in the subsurface, and transform it into non-toxic or less toxic end-products at hazardous waste sites. Natural attenuation is applicable to organic contaminants such as petroleum compounds and chlorinated solvents, as well as inorganics such as lead and chromium. It is now increasingly being used as a remedial alternative at sites contaminated with chlorinated solvents such as perchloroethylene (PCE) and trichloroethylene (TCE). It is an in situ remediation approach method which means that contaminants are left in place while natural processes mechanisms transform them.

2.1 Natural Attenuation Processes

Biological, chemical, and physical processes all contribute to natural attenuation. Biological and chemical processes are termed "destructive" because contaminant mass is reduced as constituents are destroyed or transformed into innocuous end-products. Physical processes such as adsorption, dispersion, and advection are termed "non-destructive" because they reduce contaminant concentrations or decreasing their mobility without a total mass reduction within the aquifer.

Biological attenuation, the most important destructive process for chlorinated solvents, utilizes naturally occurring microorganisms (bacteria or fungi) to break down or degrade hazardous substances into less toxic or non-toxic ones. Microorganisms, like humans, eat and digest organic substances for nutrition and energy. Certain microorganisms in the subsurface can digest organic substances such as fuels or chlorinated solvents that are hazardous to humans. Biodegradation can occur in the presence of oxygen (aerobic) or without oxygen (anaerobic); the highly chlorinated solvents such as PCE and TCE generally require anaerobic conditions for degradation.

2.2 Biodegradation of Chlorinated Solvents

Reductive dechlorination is the most important process in biodegradation of chlorinated solvents. As the name suggests, reductive dechlorination occurs when chlorine atoms in PCE and TCE are substituted with hydrogen to successively transform these compounds into daughter products such as cis-1,2, dichloroethene (cis- 1,2-DCE) and vinyl chloride (VC). The process does not proceed chemically, but uses indigenous microorganisms in the subsurface that possess the enzymatic capability to carry out the degradation. However, reductive dechlorination occurs only under reducing conditions, i.e., the aquifer must be reduced or anaerobic in nature (low in dissolved oxygen).

As a result of the natural reductive dechlorination process, daughter products or intermediate biological breakdown products are formed. These products, such as VC, are also contaminants of concern and require evaluation for further natural degradation. However, daughter breakdown products generally degrade under different geochemical conditions than their parent compounds. Because some (such as DCE and VC) degrade faster under aerobic or oxidized conditions, the pattern of degradation, or the degradative pathway, may be different from that for highly chlorinated compounds. These patterns require screening and evaluation to assess the potential for monitored natural attenuation (MNA) at a contaminated site.

In addition to interference by dissolved oxygen (DO) in biological reductive dechlorination, other natural organic and inorganic compounds play a significant role in determining a site's suitability for natural attenuation. These parameters are collectively known as the geochemistry of the aquifer, which refers to the availability of natural organic matter (total organic carbon) or anthropogenic carbon in the form of BTEX, and the presence of iron species, nitrate, and sulfate. DO, iron species (specifically ferric iron), nitrate, and sulfate compete with PCE and TCE in the microbial breakdown of natural or anthropogenic carbon. In other words, these inorganic species,

particularly DO above certain concentrations, impede or even block microbial utilization and eventual destruction of PCE and TCE.

Biological reductive dechlorination is a specific process that can proceed naturally under specific conditions. These geochemical conditions must be examined thoroughly by obtaining site-specific geochemical data and evaluating the potential for natural attenuation.

2.3 Evaluation of Natural Attenuation

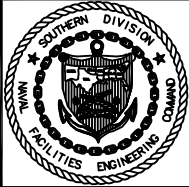
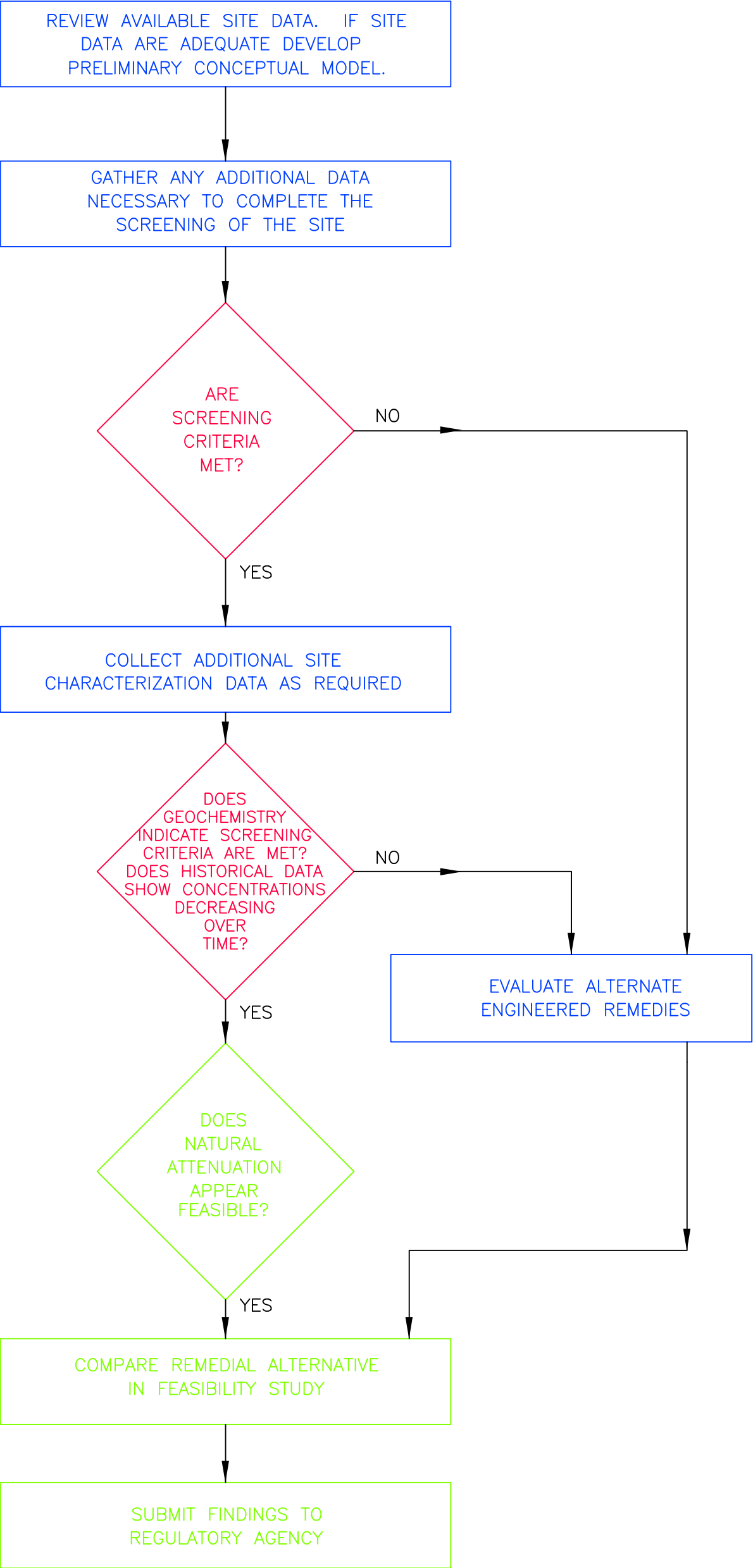
MNA evaluation follows the same general process as any other engineered remedial alternative. However, since the MNA alternative is a natural process that occurs without human intervention, more thorough and specific chemical and microbial monitoring is required to ensure that the contaminants are degrading, and that the process is protective of human health and the environment. The United States Environmental Protection Agency (USEPA) has established a technical protocol to identify the steps in evaluating natural attenuation of chlorinated solvents in groundwater. The protocol provides recommendations for analyzing and interpreting the data from site characterization and geochemical analysis (USEPA, September 1998). USEPA Region 4 has also provided suggested practices for evaluating natural attenuation at chlorinated solvent sites (November 1997).

Evaluating biological processes, which are the prime mechanisms for destroying chlorinated solvents, is the most critical step in the MNA evaluation. Once basic site characterization is complete and the nature and extent of contamination is determined, groundwater geochemistry is evaluated to determine the potential for successful natural attenuation. If geochemistry shows that the site is conducive to natural attenuation (primarily natural biodegradation), the evaluator then decides how to implement natural attenuation and verify its effectiveness. However, if aquifer geochemistry shows little potential for natural biodegradation to occur, the evaluator generally concludes the MNA investigation at this stage and recommends evaluation of active or engineered remediation alternatives.

Figure 2.1 is a flow chart of the natural attenuation evaluation process depicting how natural attenuation fits into the remedial selection process. Generally, successful implementation of the MNA remedial option includes the following steps:

1. Review of available site data and development of a preliminary conceptual model.
2. Site screening for MNA potential.
3. Collection of additional site characterization data, as required.
4. Evaluation of natural attenuation potential and examination of different lines of evidence for its success, such as:
 - a. geochemical evaluation and screening
 - b. estimating reductive capacity of the site
 - c. historical evidence of contaminant reduction, if available
 - d. microcosm tests, if required and applicable
 - e. fate and transport modeling, if required and applicable
5. Identification of current and future receptors and analysis of exposure pathways.
6. Presentation of findings and long-term MNA verification plan to the regulatory agency.

Steps 1 through 6 are generally a sequential procedure in the MNA evaluation and serve as a guide for the MNA evaluator. However, depending on the needs of a particular site, these steps could overlap considerably.



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3.0 PROTOCOL FOR EVALUATING NATURAL ATTENUATION

The USEPA (September 1998) technical protocol identifies parameters for evaluating natural attenuation of chlorinated solvents in groundwater, and provides recommendations for analyzing and interpreting data from site characterization and geochemical analysis (USEPA, September 1998).

3.1 Screening Processes for Natural Attenuation

The protocol lists three lines of evidence to demonstrate natural attenuation:

1. Historical evidence of decreasing contaminant concentrations over time at critical monitoring or sampling locations in the aquifer; and a decrease in contaminant concentrations in the direction of groundwater flow.
2. Hydrogeological and geochemical data to indirectly demonstrate a decrease in contaminant concentrations.
3. Data from field or microcosm studies which directly demonstrate the effectiveness of a particular natural attenuation process in degrading the contaminants of concern.

Historical evidence is generally obtained from existing site chemical data, although many sites do not have enough data actually showing decreased contaminant concentrations over time. Even where decreases can be demonstrated, it is important to know the mechanisms for reduction in order to predict the future trend and capacity of the aquifer to naturally degrade contaminants of concern and daughter products. This can be obtained using the second line of evidence, namely geochemistry. The third line of evidence, microcosm testing is used (if required) to supplement geochemical data and if fate and transport modeling is envisioned. Therefore, MNA field testing

mainly entails collecting and analyzing groundwater samples for geochemical analysis and interpretation.

3.2 Groundwater Chemistry and Geochemistry

As explained in Section 2, the most important factor governing the potential or feasibility of natural attenuation is the aquifer geochemistry, which provides an indication of the natural attenuation capacity of the aquifer. In the evaluation process, this is very significant because biological degradation is a destructive process that transforms contaminants into innocuous products, compared to the non-destructive processes of advection, dispersion, and dilution by recharge, which reduce contaminant concentrations but do not destroy them. Therefore, unless the evaluator can demonstrate that biodegradation is the primary process in contaminant reduction, it becomes difficult to recommend natural attenuation as the remedial alternative.

USEPA protocol lists the various groundwater physical, chemical, and biological parameters that require analysis to determine if aquifer geochemistry is favorable for natural attenuation. Groundwater samples are collected from wells in the center of the plume area, and upgradient and downgradient of the center. These results are compared with values designated in the USEPA protocol, which attaches a scoring or ranking to each geochemical parameter. The total score for each individual well is then used to determine if that particular location shows inadequate evidence, limited evidence, adequate evidence, or strong evidence of degradation. Using these scores, overall site suitability for MNA can be evaluated. Appendix B lists the parameters that require geochemical analysis, the analytical methods for their determination, and USEPA's screening and scoring system and interpretations. The following section explains the significance of each parameter.

Volatile Organic Compounds (VOCs) and Semi-volatile Organic Compounds (SVOCs): VOCs and SVOCs are used to determine the type, concentration, and distribution of contaminants and

daughter products in the aquifer. They provide information on the amount of anthropogenic carbon available (in the form of BTEX) that can be used for microbial activity. VOC and SVOC concentrations also determine if contaminants are present at levels toxic to indigenous microbes, in which case natural attenuation would be infeasible until they are reduced to non-toxic levels. The presence and distribution of daughter products indicates the extent of parent compound degradation.

VOC data can be used to infer if the contaminant or its daughter breakdown products are decreasing in the direction of groundwater flow. VOC data collected over time can be used to determine whether mass decreases are occurring.

Dissolved Oxygen (DO): DO provides the most thermodynamically favorable respiratory pathway (or electron acceptor) used by microorganisms for biodegradation. DO concentrations are very critical to natural attenuation of chlorinated solvents. Because anaerobic bacteria generally cannot function at DO concentrations greater than 0.5 milligrams per liter (mg/L), reductive dechlorination will not proceed effectively above this concentration. Since native microorganisms prefer to use oxygen for respiration, the DO must be depleted before they begin utilizing other electron acceptors. The general sequence of electronic acceptor use proceeds from DO to nitrate, followed by ferric iron [Iron (III)], sulfate, and finally carbon dioxide (methanogenesis). Each sequential microbial reaction renders the aquifer more anaerobic, creating favorable conditions for reductive dechlorination.

Once the parent compound is reduced to less chlorinated compounds, aerobic conditions could play a more significant role in further degrading these by-products. This often occurs at the downgradient or leading edge of a plume, resulting in microbial destruction of daughter products such as VC.

Nitrate: After DO has been used by microorganisms, nitrate is the next favored electron acceptor for anaerobic degradation. Nitrate concentrations in the contaminated portion of the aquifer must be less than 1.0 mg/L for reductive dechlorination to occur. Nitrate concentrations exceeding 1.0 mg/L could interfere with or decrease the natural reduction of chlorinated solvents.

Total Organic Carbon (TOC): TOC concentrations in the aquifer are used to determine the amount of electron donor that microorganisms require to metabolically degrade chlorinated solvents. TOC could be natural organic carbon or anthropogenic carbon (BTEX and other petroleum constituents). The USEPA has specified that TOC in the aquifer must be greater than 20 mg/L to supply sufficient carbon for microorganisms. However, 20 mg/L is relative to the amount of chlorinated solvents in the aquifer or the type of TOC present. In other words, TOC utilization involves a qualitative understanding in addition to USEPA's stipulated criteria. At some sites, TOCs at concentrations of 2 to 5 mg/L could be sufficient to carry out the reductive dechlorination of chlorinated solvents.

Iron (II): Ferrous iron (Fe [II]) is produced from ferric iron (Fe III) by microbial activity. Reduction from Iron (III) to Iron (II) could occur during anaerobic degradation of natural or anthropogenic carbon during reductive dechlorination of the lesser chlorinated by-products of PCE and TCE, namely DCE and VC. Therefore, ferrous iron concentrations in the aquifer can be used to indicate the feasibility of chlorinated solvent degradation, particularly VC.

Sulfate and Sulfide: After microbes have depleted DO and nitrate, sulfate may be used as the next electron acceptor. This process, termed "sulfate reduction" results in the production of sulfide. Sulfate at concentrations greater than 20 mg/L could inhibit the reductive dechlorination. The presence of sulfide in the aquifer indicates that conditions are conducive to the reductive dechlorination process.

Methane: During methanogenesis, carbon dioxide is used as an electron acceptor and converted to methane. Methanogenesis generally occurs after microorganisms have already utilized oxygen, nitrate, and sulfate. The presence of methane in the aquifer is indicative of strongly reducing conditions.

Hydrogen: The amount of hydrogen in the aquifer indicates its reduced or anaerobic nature. Hydrogen concentrations can thus be used to delineate the site with respect to oxidation-reduction potential and confirm or establish methanogenic, sulfate-reducing, ferric-reducing, iron-reducing, nitrate-reducing, or aerobic zones. At some sites, this information is critical and adds to the weight of evidence for the occurrence of natural attenuation.

Alkalinity: Alkalinity sometimes increases above background in areas with significant natural microbial activity. Therefore, groundwater alkalinity in the plume could indicate the level of microbial activity and enhance the likelihood of reductive dechlorination.

Oxidation-Reduction Potential (ORP): The ORP of groundwater, also known as redox indicates the relative oxidized or reduced state of the aquifer. Biological processes generally occur within a prescribed ORP range. For instance, an ORP of <50 millivolts (mVs) indicates reducing conditions depleted of DO. ORP levels greater than this indicate aerobic conditions exist that will tend to hinder reductive dechlorination. ORP levels less than -100 mV are ideal for reductive dechlorination.

pH and Temperature: pH affects microbial activity and some types of microbial reactions. Microorganisms capable of degrading chlorinated solvents generally prefer a pH between 6 and 8 standard units. Groundwater temperature also affects microbial activity, which tends to increase with temperature up to a certain level. Below certain temperatures (generally 10° C), microbial activity decreases until it stops completely at freezing temperatures.

Chloride: Chloride produced by reductive dechlorination is generally inert and can serve as a conservative indicator parameter in the aquifer. Reductive dechlorination generally results in chloride concentrations above background in the contaminated portion of the aquifer, and chloride is, therefore, an indirect estimator of microbial activity.

3.3 Verification of MNA through Groundwater Monitoring

Groundwater monitoring, in accordance with a sampling and monitoring program, ultimately provides the most conclusive evidence of natural attenuation of chlorinated solvents in the aquifer. Groundwater monitoring becomes the final verification step in the MNA remedy once aquifer geochemistry indicates that it is conducive to natural attenuation, that chlorinated solvent concentrations (including biological daughter products) are decreasing over time, that chlorinated solvent concentrations continue to decrease in the direction of groundwater flow, and that groundwater receptors are not threatened. Monitoring can also be used to decide if other contingency or backup remedial alternatives (active, engineered alternatives) need to be implemented based on trends in chlorinated solvent concentrations over time during the MNA program.

3.4 Effect of Geochemistry on Lead Concentrations

Geochemical conditions in the aquifer have a direct impact on the ionic and chemical state of lead in groundwater. Lead precipitates or drops out of solution under reducing conditions (which can be inferred from ORP, sulfate/sulfide concentrations, DO, and hydrogen concentrations). Under sulfate-reducing conditions, lead precipitates out in the form of lead sulfide (PbS). Because PbS is insoluble in water, groundwater lead concentrations decrease under these conditions. This type of physical-chemical reaction is the most common form of natural attenuation of metals in the aquifer. As long as reducing conditions exist in the vicinity of lead occurrences, concentrations of the metal in the groundwater will continue to drop and result in an effective natural remedy.

4.0 SUMMARY OF MNA DATA

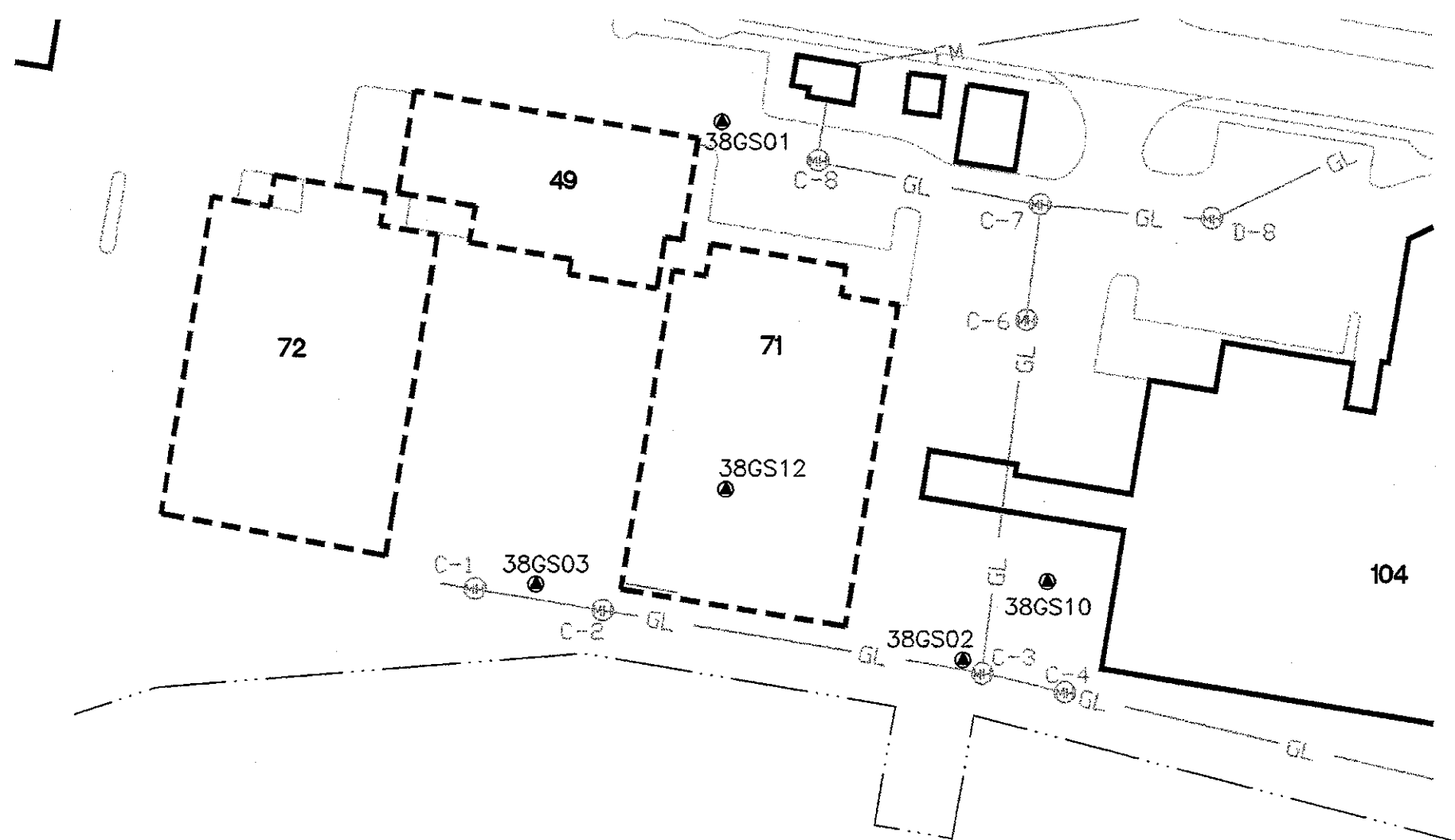
Site 38 has been divided into two areas due to historical reasons and remedial investigation results. Therefore, the Building 71 Area and the Building 604 Area were examined separately during MNA evaluation.

Building 71 Area

Figure 4.1 is a site map of the Building 71 Area showing the wells which were sampled for MNA evaluation. Figure 4.2 is a potentiometric flow map depicting groundwater flow direction in the area. Six wells were sampled during two sampling events. The first event in December 1998 was the preliminary site screening step for MNA potential, in which groundwater samples were collected from wells 38GS01 (which is considered an upgradient or background well), 38GS03, and 38GS12 and analyzed for specific geochemical parameters, VOCs, and metals. Based on this sampling, a second sampling event was performed in April 1999 to (a) confirm some of the geochemical findings of the first event, (b) collect and analyze groundwater for hydrogen concentrations which were considered critical to confirm the occurrence of sulfate-reduction (and thereby the reduction of chlorinated solvents and the decrease in lead concentrations), and (c) include additional wells for geochemical analysis, namely 38GS10 and 38GS02, which would supplement evidence for the occurrence of natural attenuation in the area. VOC data were also collected from wells 38GS10 and 38GS02.

Building 604 Area

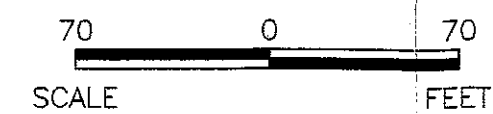
Figure 4.3 is a site map of the Building 604 Area showing the locations of the MNA wells that were sampled. Figure 4.4 is a potentiometric flow map depicting groundwater flow direction in the area. As at the Building 71 Area, two sampling events were performed, the first in December 1998 and the second in April 1999. During the first event, samples were collected from wells 38GS28 (which is considered an upgradient or background well), 38GS19, 38GS08, and 38GS32 and analyzed for the same constituents as the Building 71 Area samples. Two more wells, 38GS17 and 38GS20, were added to the list for the second sampling event. Hydrogen was also added to the list of geochemical constituents.



PENSACOLA BAY

LEGEND

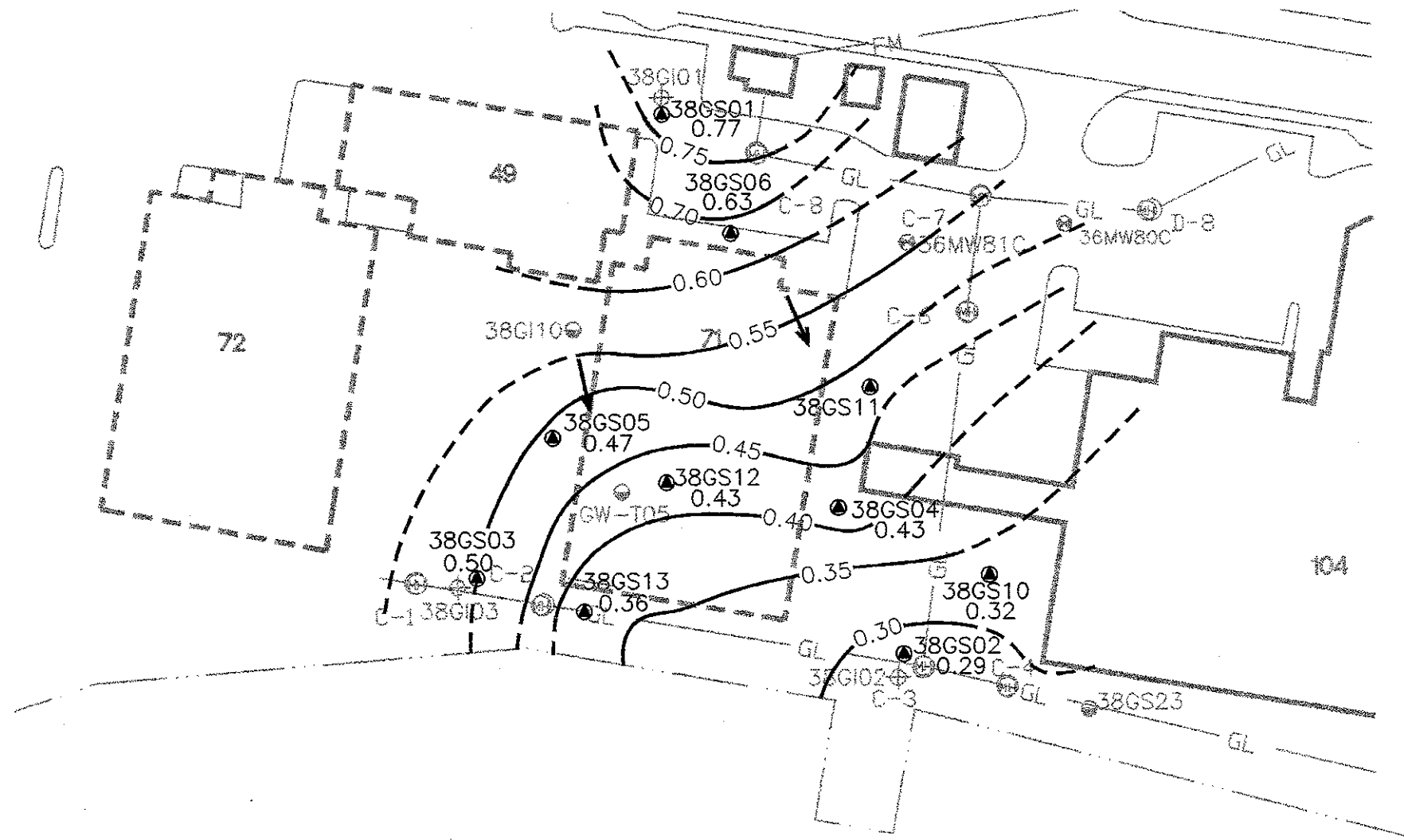
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- SHORELINE
- MNA EVALUATION WELLS
- GRAVITY LINE (SEWER)
- FORCE MAIN (SEWER)
- MANHOLE



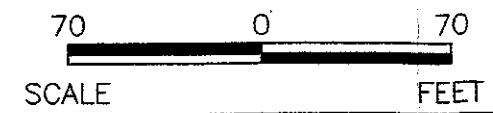
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FIGURE 4-1
BUILDING 71 STUDY AREA
MONITORING WELLS

DWG DATE: 07/14/99 | DWG NAME: 059MWB71



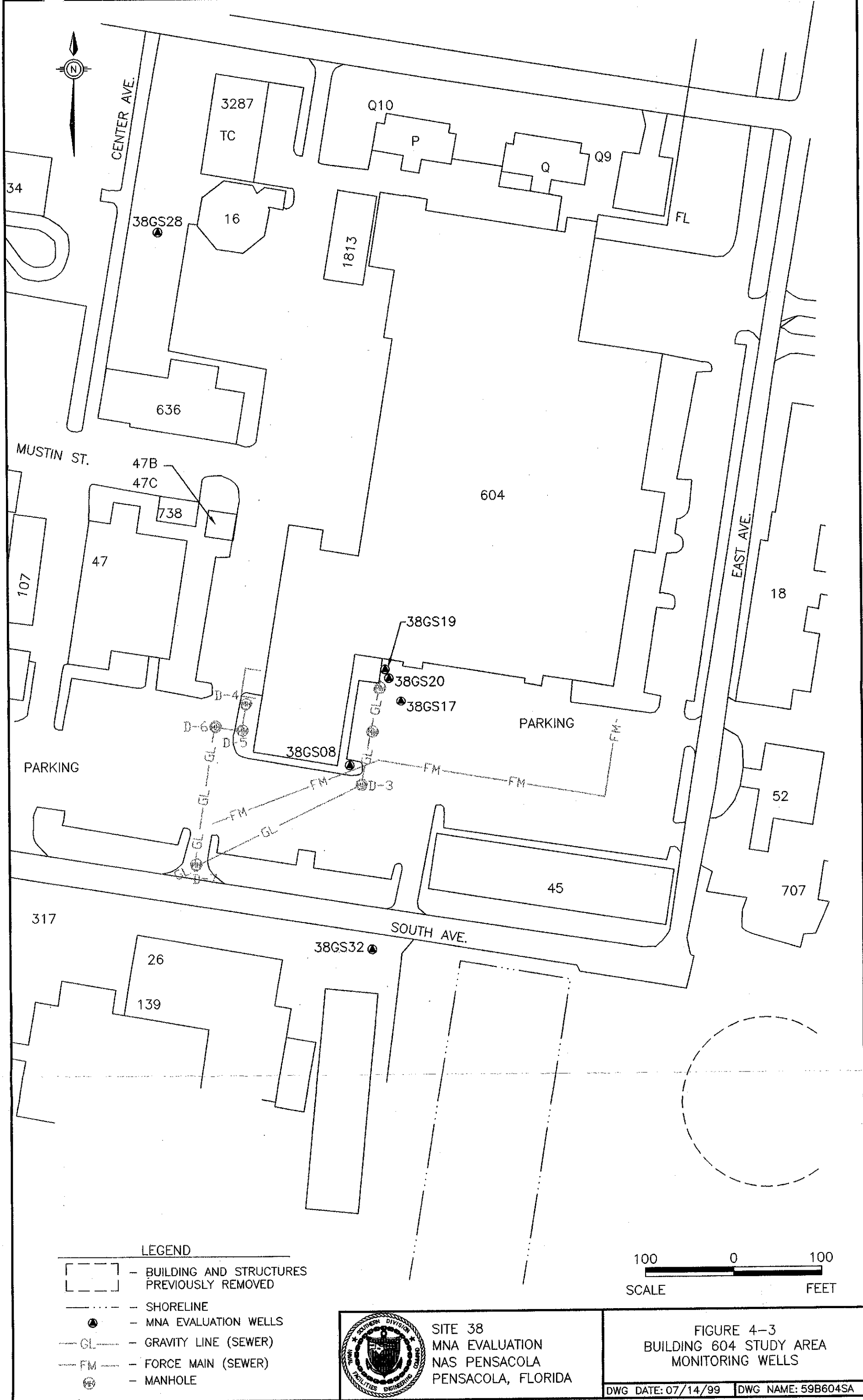
- LEGEND
- BUILDINGS AND STRUCTURES PREVIOUSLY REMOVED
 - SHORELINE
 - IWTP SEWERLINE STUDY TEMPORARY SHALLOW MONITORING WELL
 - E/A&H SITE 38 INTERMEDIATE MONITORING WELL
 - E/A&H SITE 38 SHALLOW MONITORING WELL
 - EPA WELL
 - GL - GRAVITY LINE (SEWER)
 - FM - FORCE MAIN (SEWER)
 - MANHOLE
 - GROUNDWATER FLOW DIRECTION



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FIGURE 4-2
BUILDING 71 STUDY AREA
GROUNDWATER CONTOUR MAP
HIGH TIDE DURING DRY PERIOD
12/16/98

DWG DATE: 12/01/99 | DWG NAME: 0059S004



LEGEND

- BUILDING AND STRUCTURES PREVIOUSLY REMOVED
- SHORELINE
- MNA EVALUATION WELLS
- GRAVITY LINE (SEWER)
- FORCE MAIN (SEWER)
- MANHOLE

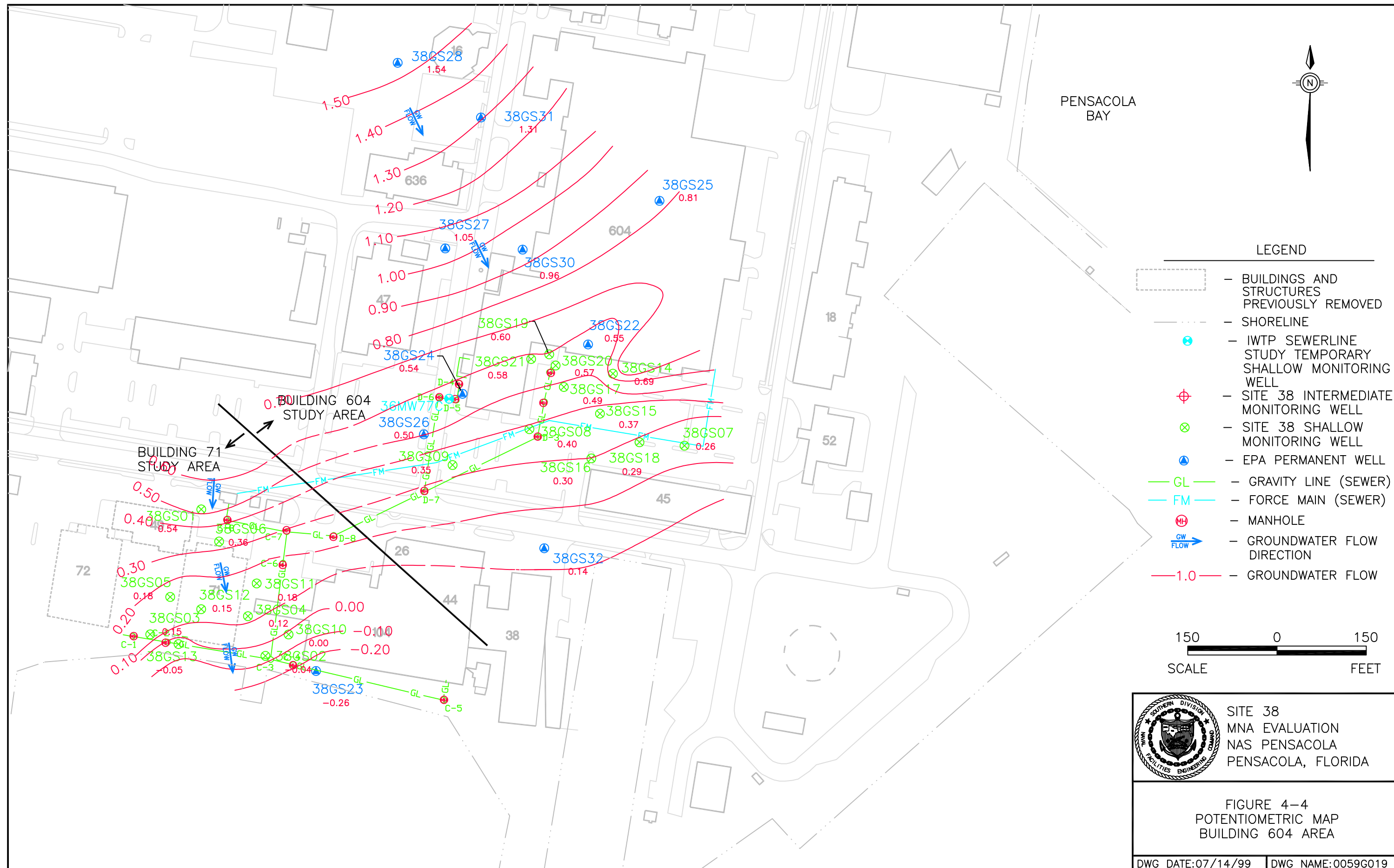


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100 0 100
SCALE FEET

FIGURE 4-3
BUILDING 604 STUDY AREA
MONITORING WELLS

DWG DATE: 07/14/99 DWG NAME: 59B604SA




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FIGURE 4-4
POTENTIOMETRIC MAP
BUILDING 604 AREA

DWG DATE: 07/14/99 | DWG NAME: 0059G019

Sampling Protocol and Analysis

Groundwater samples for off-site laboratory analysis were collected and analyzed in accordance with the site-specific sampling and analysis plan. Field sample collection and geochemical analysis were performed in accordance with the USEPA 1998 protocols listed in Appendix B. Tables 4.1 and 4.2 summarize chemical and geochemical sampling results used to assess MNA feasibility at the Building 71 and 604 areas, respectively. Field and laboratory sampling results for chemistry and geochemistry are also summarized in Appendix C.

Table 4.1
 Summary of Chemical and Geochemical Analysis

Building 71 Area						
Parameter	Units	38GS01	38GS02	38GS03	38GS10	38GS12
Dissolved Oxygen (DO)	mg/L	0.38	ND	ND	0.17	ND
pH	pH between 6.0 and 8.0					
Temperature	°C	24.9	24.8	24.0	25.0	24.3
Oxidation Reduction Potential (ORP)	millivolts (mV)	5	-345.7	-262	-327.2	-291.8
Chloride	mg/L	35	>150	150	120	75
Alkalinity	mg/L	100	160	120	120	160
Ferrous Iron (Iron II)	mg/L	ND	0.10	0.11	0.01	0.06
Nitrate	mg/L	0.5	NS	ND	NS	ND
Sulfate	mg/L	9	1.0	16.2	0	18.2
Sulfide	mg/L	ND	1.42	0.282	1.090	1.53
Methane	µg/L*	ND	360	330	580	210
Hydrogen	nM*	NS	1.34	2.5	1.34	1.94
Carbon Dioxide	mg/L	NS	NS	34.4	NS	23.06
Total Organic Carbon (TOC)	mg/L	2.87	1.6	4.56	2.3	12.4
TCE	µg/L	ND	ND	4	ND	25
cis-1,2-DCE	µg/L	ND	ND	5	ND	27
Vinyl Chloride (VC)	µg/L	ND	ND	3	ND	15
Dichloroethane (DCA)	µg/L	ND	ND	3	ND	13

Notes:

38GS01 is the background well for comparison purposes at Area 71

ND — Non-detect. NS — Not Sampled. nM — Nano-moles per liter. µg/L — micrograms per liter

Table 4.2
 Summary of Chemical and Geochemical Analysis
 Building 604 Area

Parameter	Units	38GS08	38GS17	38GS19	38GS20	38GS28	38GS32
Dissolved Oxygen (DO)	mg/L	0.51	ND	1.39	ND	0.22	0.17
pH	pH between 6.0 and 8.0						
Temperature	°C	24.1	25.0	23.8	22.4	23.8	25.2
Oxidation Reduction Potential (ORP)	millivolts (mV)	-30	-324.8	114	-305	45	-114.5
Chloride	mg/L	55	55	33.4	25	74.2	60
Alkalinity	mg/L	100	220	100	80	120	140
Ferrous Iron (Iron II)	mg/L	ND	0.03	0.01	0.12	0.06	0.15
Nitrate	mg/L	0.737	NS	1.86	NS	0.136	ND
Sulfate	mg/L	18	16	24	15	11.8	8.8
Sulfide	mg/L	ND	10.75	0.001	0.440	0.001	0.004
Methane	µg/L*	ND	5300	ND	1700	460	210
Hydrogen	nM*	0.90	5.6	0.50	3.11	0.67	0.73
Carbon Dioxide	mg/l	NS	60.76	NS	5.86	43.55	9.52
Total Organic Carbon (TOC)	mg/L	2.94	29	2.44	3.9	7.10	3.37
TCE	µg/L	24	ND	22	ND	ND	5
cis-1,2-DCE	µg/L	25	ND	27	ND	ND	25
Vinyl Chloride (VC)	µg/L	ND	ND	3	15	ND	14
DCA	µg/L	ND	ND	ND	ND	ND	ND

Notes:

38GS28 is the background well for comparison purposes at Area 604

ND — Non-detect. NS — Not Sampled. nM — Nano-moles per liter. µg/L — micrograms per liter

5.0 RESULTS AND EVALUATION OF NATURAL ATTENUATION

Groundwater sampling results, summarized in Tables 4.1 and 4.2, were processed using USEPA's MNA ranking system to assess the adequacy or feasibility of MNA at the site. The following interpretation of the scoring (Table 5.1), or points system is adapted from USEPA's MNA protocol.

Table 5.1
Interpretation Criteria for Examining MNA Feasibility

Score	Interpretation
0 to 5	Inadequate evidence
6 to 14	Limited evidence
15 to 20	Adequate evidence
> 20	Strong evidence

Table 5.2 summarizes the scoring system for the two areas. Wells 38GS01 and 38GS28 were considered background wells and were used primarily to allocate scores for chloride and alkalinity concentrations in each area.

5.1 Interpretation of Geochemical and Chemical Analysis and its Effect on Reductive Dechlorination

5.1.1 Building 71 Area

Geochemistry

Table 5.2 shows considerable evidence to demonstrate the occurrence of reductive dechlorination of PCE and TCE in the Building 71 area. Well 38GS12 in the center of the contamination, had a score or ranking of 27 which suggests that there is strong evidence of natural reductive chlorination. Downgradient location well 38GS03 also showed strong evidence of reductive dechlorination, while two other downgradient wells, 38GS02 and 38GS10, also showed adequate evidence of its occurrence. Significant chemical and geochemical parameters and findings of the MNA investigation that support strong evidence of MNA are summarized below:

Table 5.2
 MNA Effectiveness Evaluation Summary
 Building 71 Area

Parameter	Well	38GS02	38GS03	38GS10	38GS12	38GS08	38GS17	38GS19	38GS20	38GS32
DO		3	3	3	3	3	3	0	3	3
Temperature		1	1	1	1	0	0	0	0	0
pH		0	0	0	0	1	1	1	1	1
ORP		2	2	2	2	1	2	0	2	2
Chloride		2	2	2	2	0	0	0	0	0
Alkalinity		0	0	0	0	0	1	0	0	0
Iron II		0	0	0	0	0	0	0	0	0
Nitrate		NS	2	NS	2	2	NS	NS	NS	2
Sulfate		2	2	2	2	2	2	0	2	2
Sulfide		3	2	3	3	0	3	0	1	0
Methane		3	3	3	3	0	3	0	3	2
Hydrogen		3	3	3	3	1	3	0	3	0
Carbon Dioxide		NS	0	NS	0	NS	NS	0	0	0
TOC		0	0	0	0	0	2	0	0	0
cis-1,2-DCF		0	2	0	2	2	0	2	0	2
Vinyl Chloride		0	2	0	2	0	0	2	2	2
DCA		0	2	0	2	0	0		0	NS
Total Points Scored		19	26	19	27	12	20	5	17	16
Interpretation/Effectiveness/Evidence		Adequate	Strong	Adequate	Strong	Limited	Adequate	Inadequate	Adequate	Adequate

Note:
 NS — Not sampled

Dissolved Oxygen (DO): DO is probably the most critical parameter in the geochemical suite. Low or non-detect concentrations of DO are supportive of natural reductive dechlorination because high DO hinders, or even prevents, chlorinated solvent degradation. Table 4.1 indicates that the aquifer is almost devoid of DO which makes it anaerobic or highly reducing.

Oxidation-Reduction Potential (ORP): ORP measurements in groundwater provide further evidence of the reductive nature of the aquifer, a condition that is vital to the reductive dechlorination process. ORP readings less than 50 mV generally suggest anaerobic or reducing conditions. At all the wells in the plume except for upgradient well 38GS01, the ORP was well below -100 mV indicating conditions strongly favor reductive dechlorination.

Nitrate: Nitrate at higher concentrations (> 1 mg/L) could impede the reductive dechlorination process. Nitrate at 38GS12 and one of the other downgradient locations (38GS03) was below the method detection level. Therefore, it is unlikely that nitrate will inhibit reductive dechlorination.

Sulfate and Sulfide: Sulfate below 20 mg/L generally does not interfere with the reductive dechlorination process. However, at higher concentrations, sulfate could compete with TCE and PCE for microbial respiration. Sulfate concentrations in this area were all below 20 mg/L. However, sulfide was present at concentrations of 16.2 and 18.2 mg/L at 38GS03 and 38GS12, respectively, indicating a significant mass of electron acceptors in present.

The presence of sulfide indicates reducing conditions in the aquifer which facilitate reductive pathways for TCE and PCE. Sulfide was detected in all area wells with a maximum concentration of 1.53 mg/L at 38GS12 clearly indicating the reductive nature of the aquifer.

Hydrogen: Hydrogen was measured during the second event (April 1999) to support evidence for reductive dechlorination found in the December 1998 sampling. The range of hydrogen

concentrations (1.34 to 2.5 nM) further indicates that the majority of the aquifer is in the sulfate-reducing mode of anaerobic activity, making it conducive to reductive dechlorination.

Methane: Methane was detected in the aquifer with a maximum concentration of 580 $\mu\text{g/L}$ at 38GS10. Methane detections further indicate that methanogenesis is occurring along with sulfate reduction, although to a lesser degree. Methanogenic conditions are considered the most favorable for reductive dechlorination of PCE, TCE, and their daughter products. The higher the methane concentrations ($> 1,000 \mu\text{g/L}$ and above are considered optimal), the more it is likely that PCE and TCE will degrade completely to innocuous end-products such as ethane and ethene. However, even methane concentrations in the 100 to 500 $\mu\text{g/L}$ range can indicate there are pockets of methanogenic activity in the aquifer.

Chloride: The end-product of reductive dechlorination is chloride, which is a non-reactive (conservative) constituent often used as an indicator parameter to demonstrate chlorinated solvent breakdown. When chloride is present at concentrations greater than twice the background, it is likely that significant reductive dechlorination is occurring. In the Building 71 Area, chloride concentrations were consistently four to five times background concentrations.

Total Organic Carbon (TOC): For reductive dechlorination to occur, the microorganisms must have an adequate supply of natural or anthropogenic carbon. The 20 mg/L value listed in the USEPA protocol is an optimal concentration for reductive dechlorination and is relative to the concentrations of TCE and PCE. However, at most sites, a TOC concentration much less than this is sufficient to drive the reductive dechlorination, provided the aquifer is a reducing one. In the Building 71 Area, TOC values of 12.4 mg/L at 38GS12 and 4.56 mg/L at 38GS03 are relatively high compared to the concentrations of PCE and TCE and should support continuing degradation in the aquifer.

Site Chemical Data and Historical Trends

Table 5.3 summarizes chlorinated solvent concentrations in Building 71 Area since sampling first began in January 1994. Figures 5.1 through 5.5 depict changes in concentration of chlorinated solvents and their daughter breakdown products in each well in the area (for which data are available) since 1994 when sampling began. Figures 5.6 through 5.8 show changes in concentration in the approximate direction of groundwater flow in the area. Concentrations of chlorinated solvents show an overall decreasing trend in the direction of groundwater flow from well 38GS12 to the downgradient wells 38GS03, 38GS02, and 38GS10. This indicates that PCE and TCE are undergoing reductive dechlorination before reaching the downgradient wells. Overall, since sampling began in 1994, concentrations have also decreased over time (with the exception of PCE at 38GS12). However, evidence points to a decrease in groundwater PCE concentrations during all sampling events and very strong geochemical evidence at 38GS12 which should assist PCE degradation.

The products of reductive dechlorination, cis-1,2-DCE and vinyl chloride shows trends similar to their parent compounds, indicating that these by-products are not accumulating in the aquifer. Detections at well 38GS03 for TCE (5 $\mu\text{g/L}$) and vinyl chloride (3 $\mu\text{g/L}$) are only slightly above their screening concentrations. The overall geochemical screening indicated that conditions are still very favorable for reductive dechlorination at this location, indicating that downgradient accumulation of parent or daughter compounds is not likely.

5.1.2 Building 604 Area

Geochemistry

Table 5.2 shows fair evidence of reductive dechlorination of PCE and TCE in the Building 604 area. Among the wells in the center of contamination (38GS17, 38GS19, and 38GS20), 38GS19 was the only one that showed inadequate evidence of reductive dechlorination. However, this location is probably an isolated aerobic locale or micro-environment within the aquifer. Even at

Figure 5.1 Tetrachloroethene Building 71 Well Concentrations

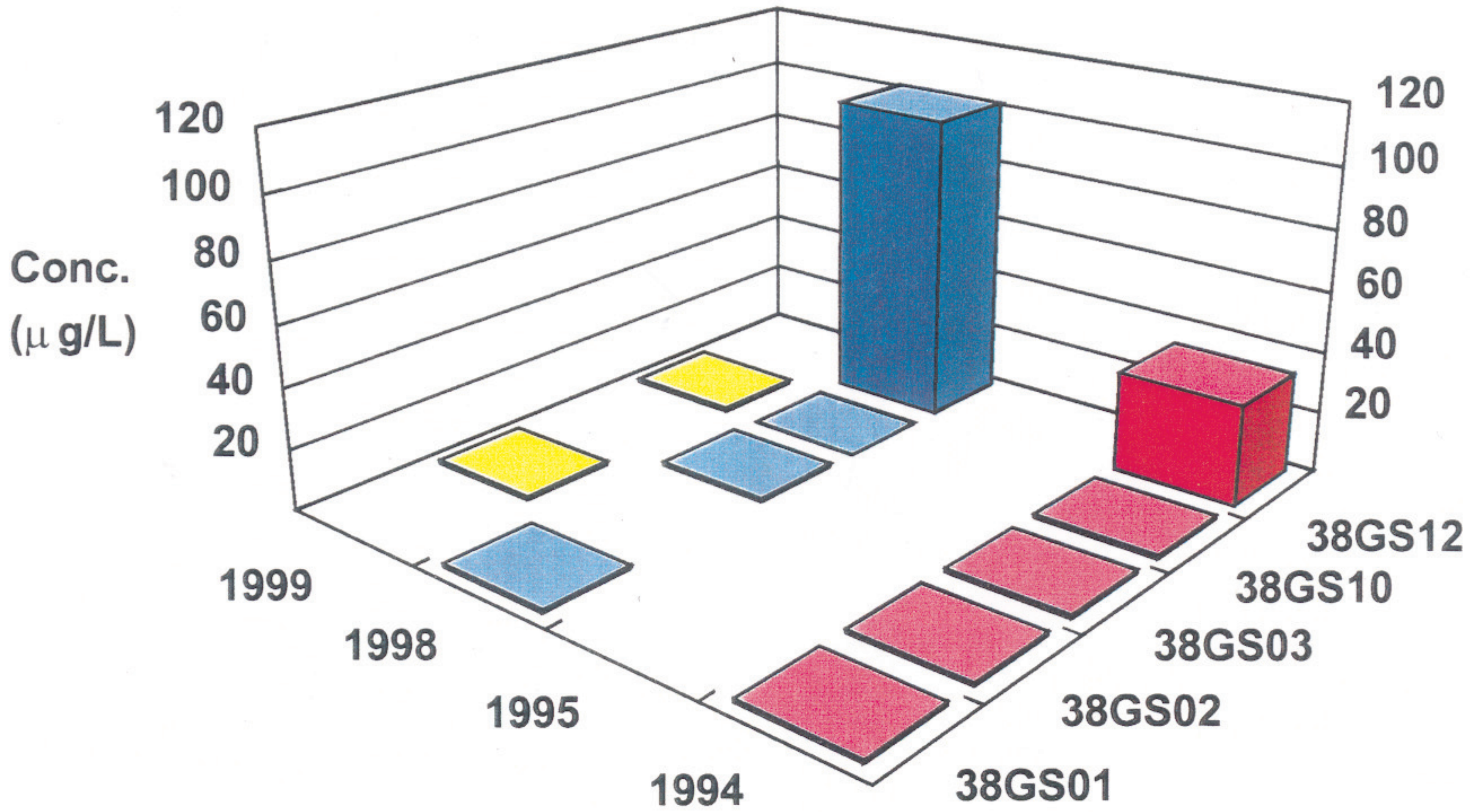


Figure 5.2 Trichloroethene Building 71 Well Concentrations

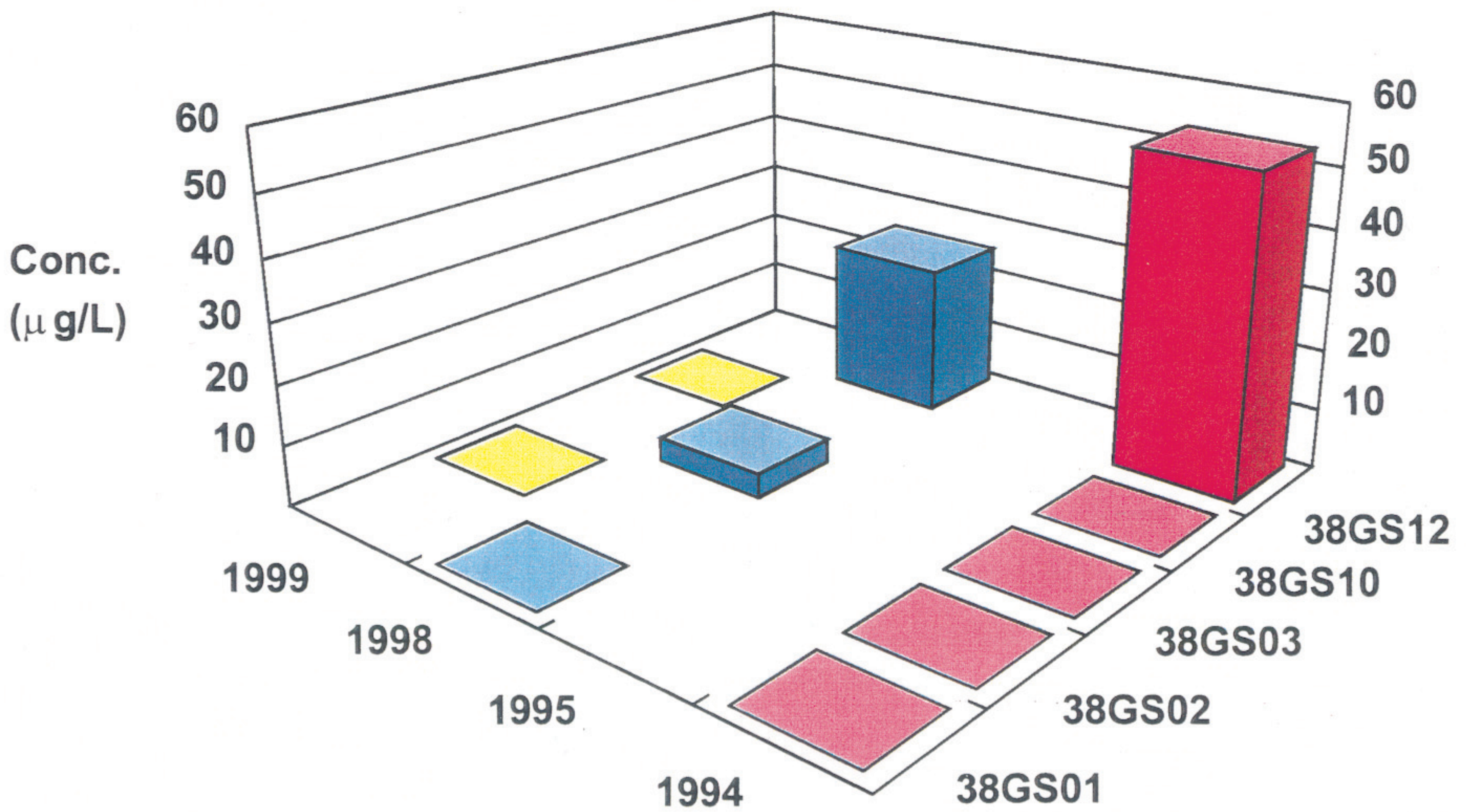


Figure 5.3 cis-1,2 -Dichloroethene Building 71 Well Concentrations

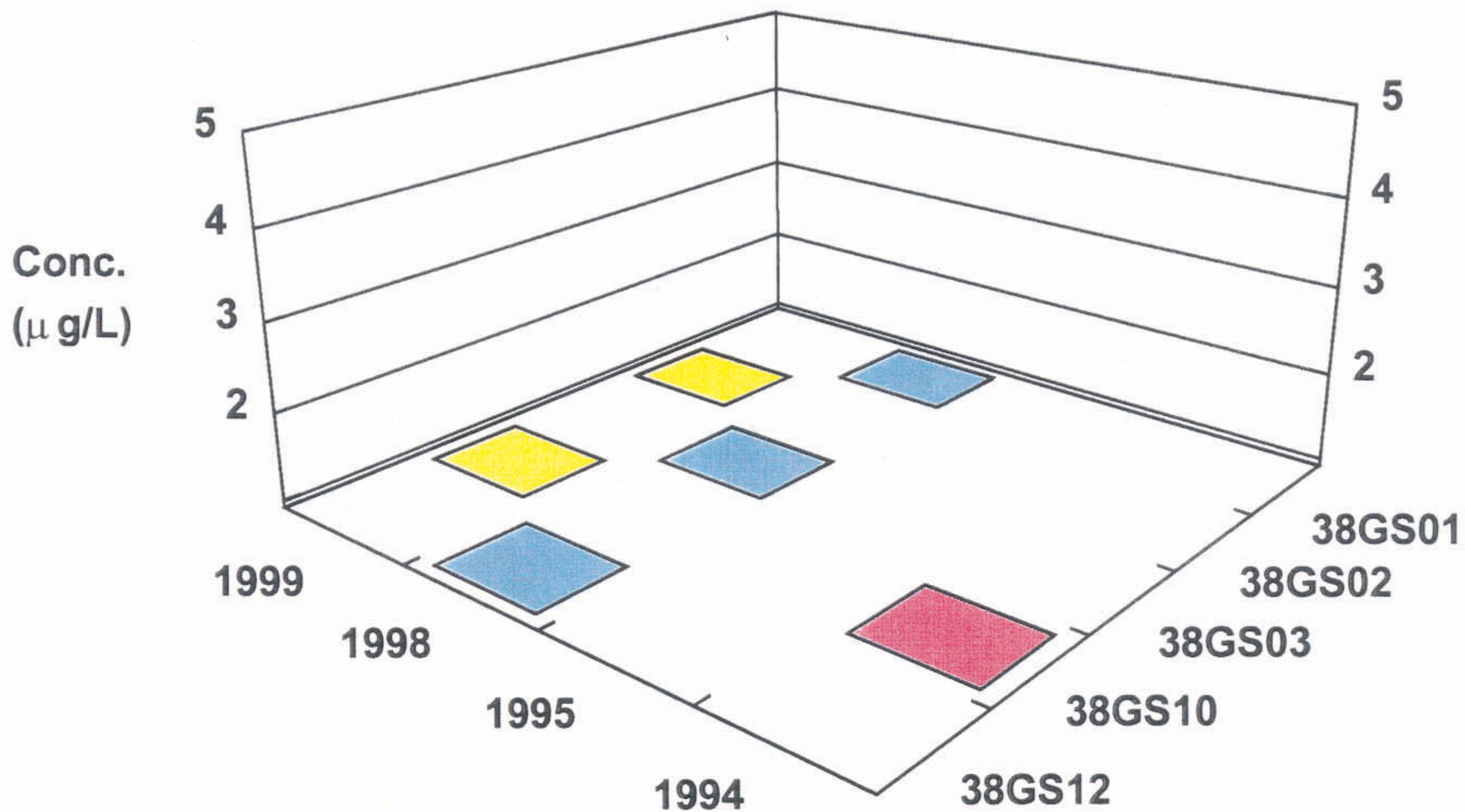


Figure 5.4 1,1-Dichloroethane Building 71 Well Concentrations

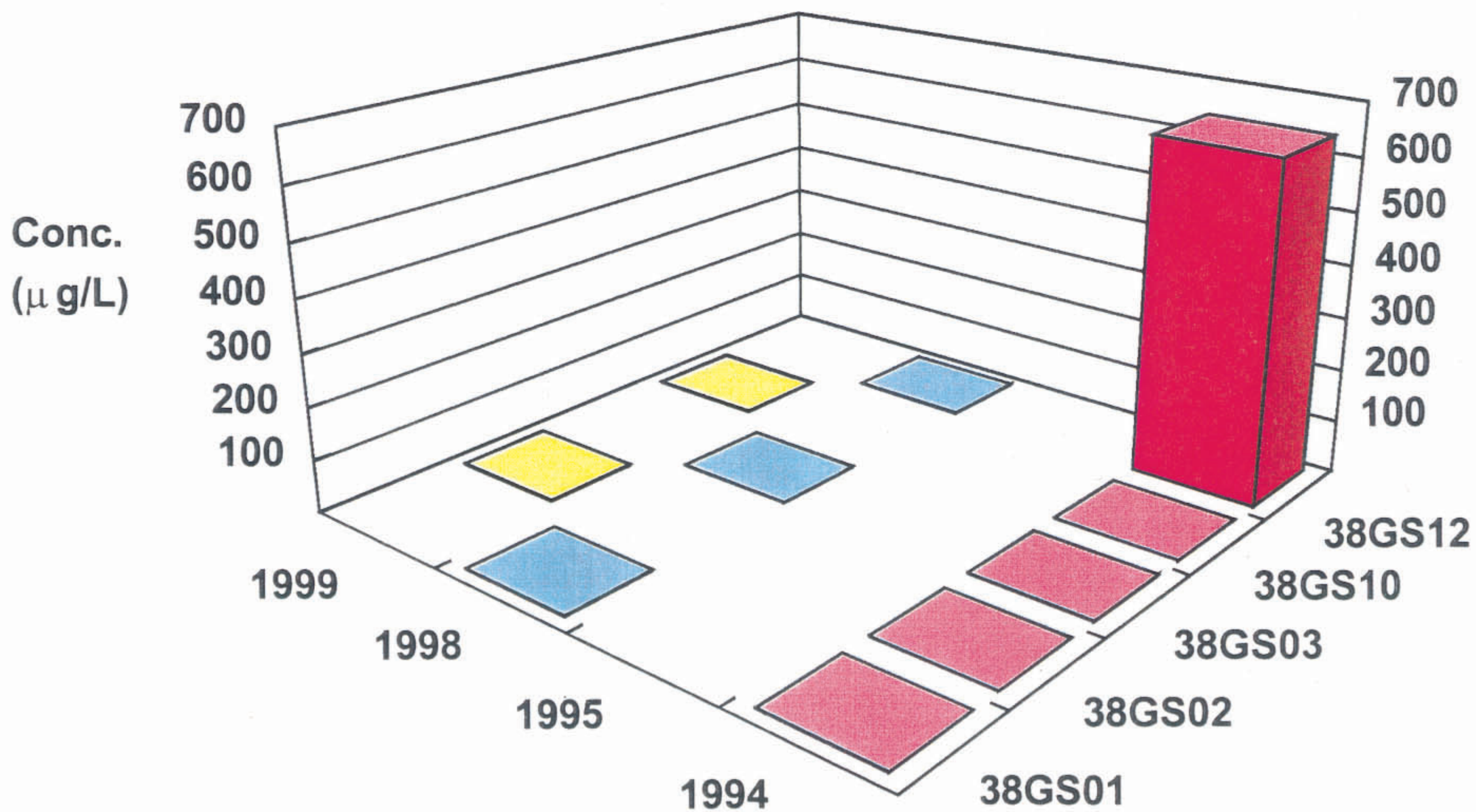


Figure 5.5 Vinyl Chloride Well Concentrations Building 71

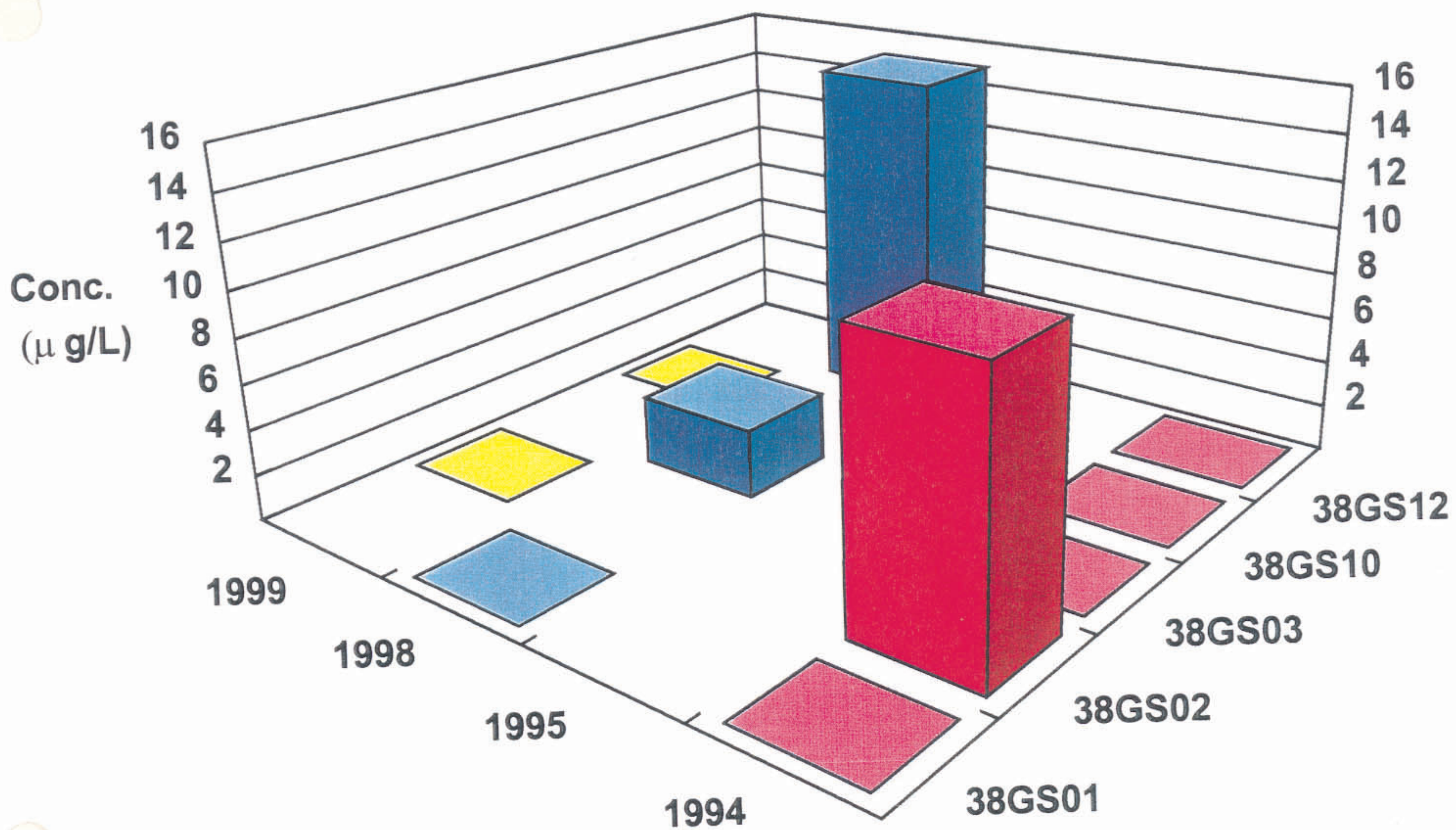


Figure 5.6 Bldg 71 1994 Natural Attenuation of Chlorinated Solvents

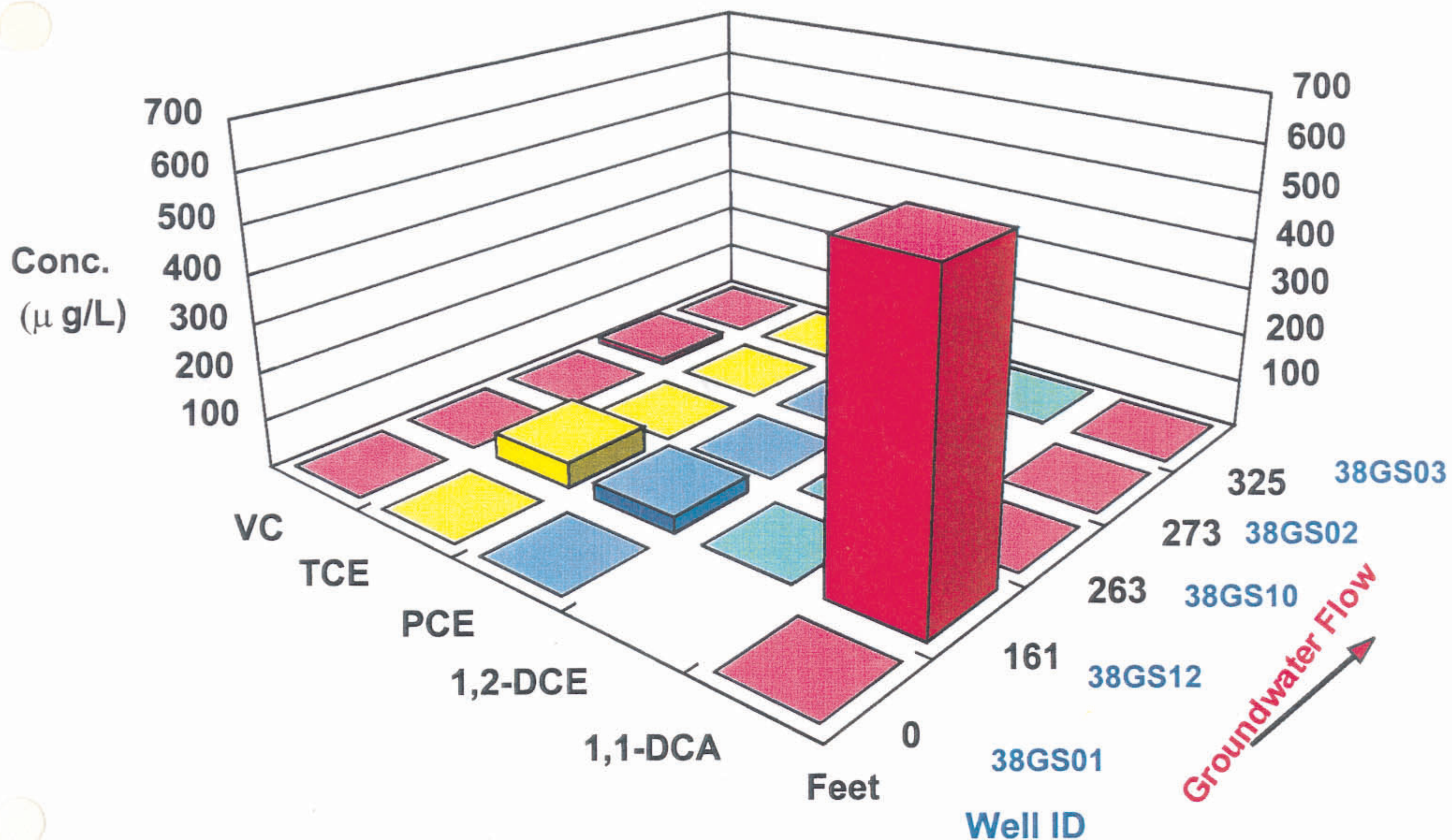


Figure 5.7 Bldg 71 1998 Natural Attenuation of Chlorinated Solvents

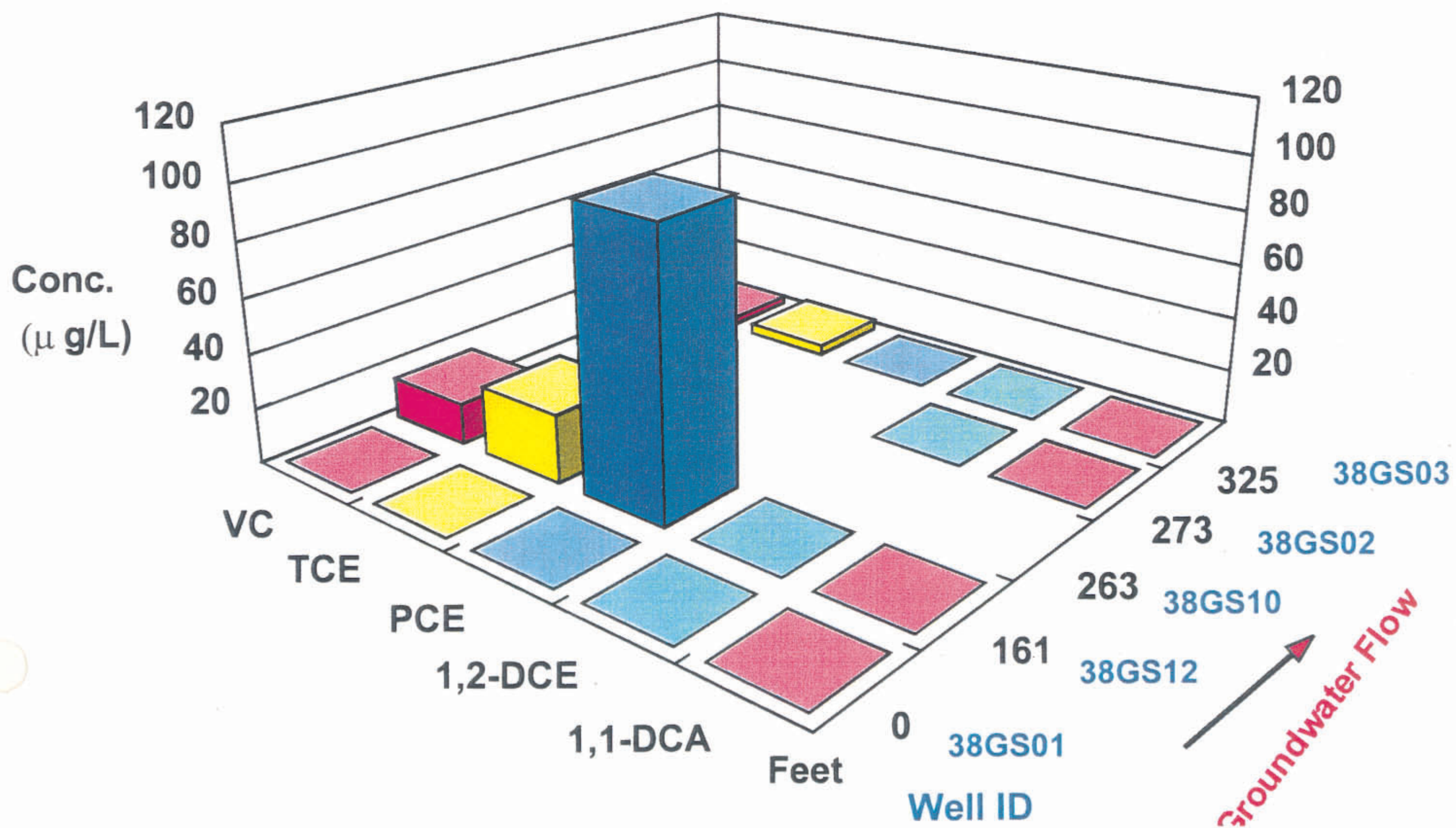


Figure 5.8 Bldg 71 1999 Natural Attenuation of Chlorinated Solvents in Groundwater NAS Pensacola

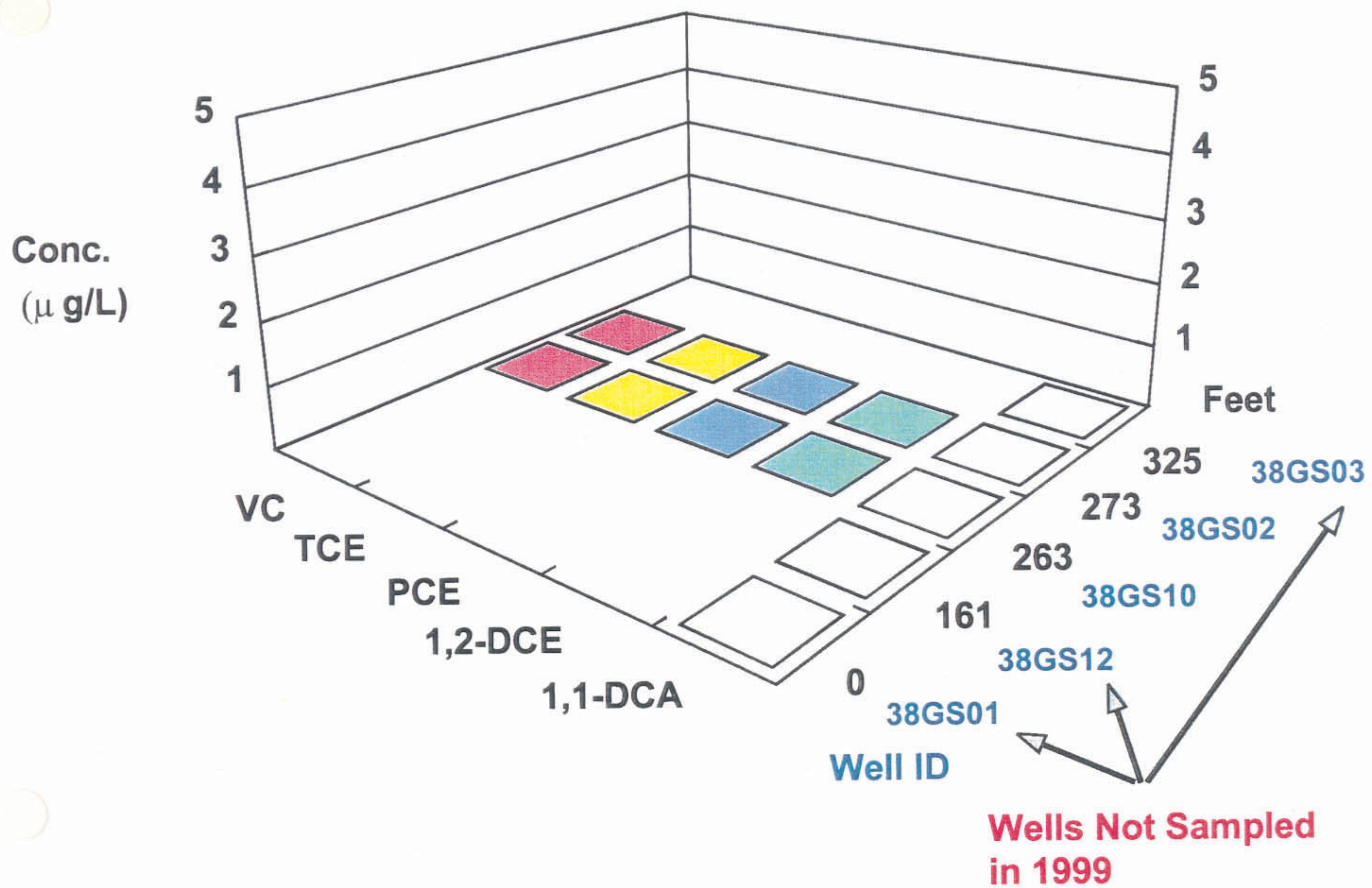


Table 5.3
 Site 38 — 1994-1999
 Historical Data for Chlorinated Solvents
 Detected in Groundwater at the Building 71 Area

Parameter	Location	RI Samples (Jan 1994)	EPA Samples (Oct 1995)	Samples (Dec 1998)	Samples (May 1999)	Screening Concentration	Screening Source
Volatile Organic Compounds ($\mu\text{g/L}$)							
1,1-Dichloroethane	38GS01	ND	NS	ND	NS	700	FGGC
	38GS02	44	NS	NS	ND		
	38GS03	ND	NS	3	NS		
	38GS10	ND	NS	NS	ND		
	38GS12	640	NS	13	NS		
cis-1,2-Dichloroethene	38GS01	NA	NS	ND	NS	70	FPDWS
	38GS02	NA	NS	NS	ND		
	38GS03	NA	NS	5	NS		
	38GS10	ND	NS	NS	ND		
	38GS12	NA	NS	27	NS		
Tetrachloroethene	38GS01	ND	NS	ND	NS	3	FPDWS
	38GS02	ND	NS	NS	ND		
	38GS03	ND	NS	ND	NS		
	38GS10	ND	NS	NS	ND		
	38GS12	33	NS	102	NS		
Trichloroethene	38GS01	ND	NS	ND	NS	3	FPDWS
	38GS02	ND	NS	NS	ND		
	38GS03	1	NS	4	NS		
	38GS10	2	NS	NS	ND		
	38GS12	53	NS	25	NS		
Vinyl Chloride	38GS01	ND	NS	ND	NS	1	FPDWS
	38GS02	12	NS	NS	ND		
	38GS03	ND	NS	3	NS		
	38GS10	ND	NS	NS	ND		
	38GS12	ND	NS	15	NS		

Notes:

ND — Parameter not detected in this sample.
 NA — Parameter not analyzed for this sample.
 NS — Well not sampled during this event.
 Concentrations exceeding screening values are in bold.

this location (38GS19), PCE concentrations have decreased from 240 $\mu\text{g/L}$ to 22 $\mu\text{g/L}$ in a three-year period. 38GS32, which is farthest downgradient, showed adequate evidence of microbial degradation. Significant chemical and geochemical parameters and findings, and MNA investigation results that support the evidence of MNA are summarized below.

Dissolved Oxygen (DO): Table 4.2 indicates that DO concentrations in the aquifer (except at 38GS19) were generally below the critical value of 0.5 mg/L, the point at which anaerobic degradation occurs.

Oxidation-Reduction Potential (ORP): ORP readings less than 50 mV generally suggest anaerobic or reducing conditions. At three wells in the area (38GS17, 38GS20, and 38GS32), the ORP was well below -100 mV, indicating conditions strongly favor reductive dechlorination. The main exception was at 38GS19 where the ORP was 114 mV, confirming an aerobic locale around this well.

Nitrate: Nitrate at higher concentrations ($> 1 \text{ mg/L}$) could impede or slow down the reductive dechlorination process. Nitrate was below 1.0 mg/L in the aquifer, except at 38GS19, which had a concentration of 1.86 mg/L. However, reductive dechlorination activity in the major portion of the aquifer in this area is unlikely to be impacted by nitrate.

Sulfate and Sulfide: Sulfate up to 20 mg/L generally does not interfere with the reductive dechlorination process. However, at higher concentrations, sulfate could compete with TCE and PCE for microbial consumption. Sulfate concentrations in this area were all below 20 mg/L (with the exception of 38GS19). Concentrations of 15 and 16 mg/L at 38GS20 and 38GS17, respectively, indicate an adequate mass of electron acceptors is available.

The presence of sulfide in the aquifer indicates that the aquifer is reducing and reductive pathways for TCE and PCE are possible. Sulfide was detected in two of the wells in the center of contamination, 38GS17 and 38GS20, indicating the reductive nature of the aquifer and its conduciveness to reductive dechlorination. The sulfide concentration of 10.75 mg/L at 38GS17 was very high, suggesting reductive dechlorination is occurring.

Hydrogen: Hydrogen was measured during the second event (April 1999) to support the evidence for reductive dechlorination found during the December sampling. Hydrogen concentrations in the critical wells (38GS17 and 38GS20) were above 3 mg/L, suggesting that sulfate-reduction and methanogenesis are occurring.

Methane: Methane was also detected at 1,700 $\mu\text{g/L}$ at 38GS20 and at 5,300 $\mu\text{g/L}$ at 38GS17. Methane detections further indicate that along with sulfate reduction, methanogenesis is also occurring. Methanogenic conditions are considered the most favorable for reductive dechlorination of PCE, TCE, and also its daughter products. The higher the methane concentrations ($> 1,000 \mu\text{g/L}$ and above are considered optimal), the more likely it is that PCE will degrade completely to innocuous end-products such as ethane and ethene.

Total Organic Carbon (TOC): For reductive dechlorination to occur, microorganisms must have a supply of natural or anthropogenic carbon. The value of 20 mg/L listed in the EPA protocol as being an optimal concentration for reductive dechlorination is relative to the concentrations of TCE and PCE. At most sites, a TOC concentration much less than this is sufficient to drive reductive dechlorination, provided the aquifer is a reducing one. In the Building 604 Area, TOC values of 29 mg/L at 38GS17 and 7.10 mg/L at 38GS20 are relatively high compared to PCE and TCE concentrations, and should support continued degradation in the aquifer.

Site Chemical Data and Historical Trends

Table 5.4 summarizes chlorinated solvent concentrations in the Building 604 Area since sampling began in January 1994. Figures 5.9 through 5.12 depict changes in concentration of chlorinated solvents and their daughter breakdown products in each well in the area (for which data are available) since 1994 when sampling began. Figures 5.13 through 5.15 show changes in concentration in the approximate direction of groundwater flow in the area. PCE concentrations have decreased over time in all wells sampled. The largest decrease has been noted at 38GS19, with reductions from 240 $\mu\text{g/L}$ to 22 $\mu\text{g/L}$ over three years. The wells that show the strongest evidence of reductive dechlorination (38GS17 and 38GS20) are now non-detect for PCE for PCE.

TCE concentrations have also decreased over a three-year monitoring period with wells 38GS17 and 38GS20 now at non-detect. TCE concentrations at downgradient well 38GS32 have shown the largest decrease, from 340 to 5 $\mu\text{g/L}$, in the same period.

Figures 5.13 through 5.15 show that in addition to reducing concentrations over time in each individual well, the general pattern indicates an overall decrease in chlorinated solvents in the direction of groundwater flow.

Concentrations of daughter products, particularly vinyl chloride, show a similar decreasing trend over time. The greatest decrease has been at well 38GS17, where VC concentrations have decreased from 3,700 $\mu\text{g/L}$ to non-detect in three years. Vinyl chloride concentrations at downgradient well 38GS32 have also decreased significantly, from 130 $\mu\text{g/L}$ to 14 $\mu\text{g/L}$, during this time. These decreases in VC concentrations over time strongly suggest that this critical daughter product is not accumulating in the aquifer.

Figure 5.9 Tetrachloroethene Building 604 Well Concentrations

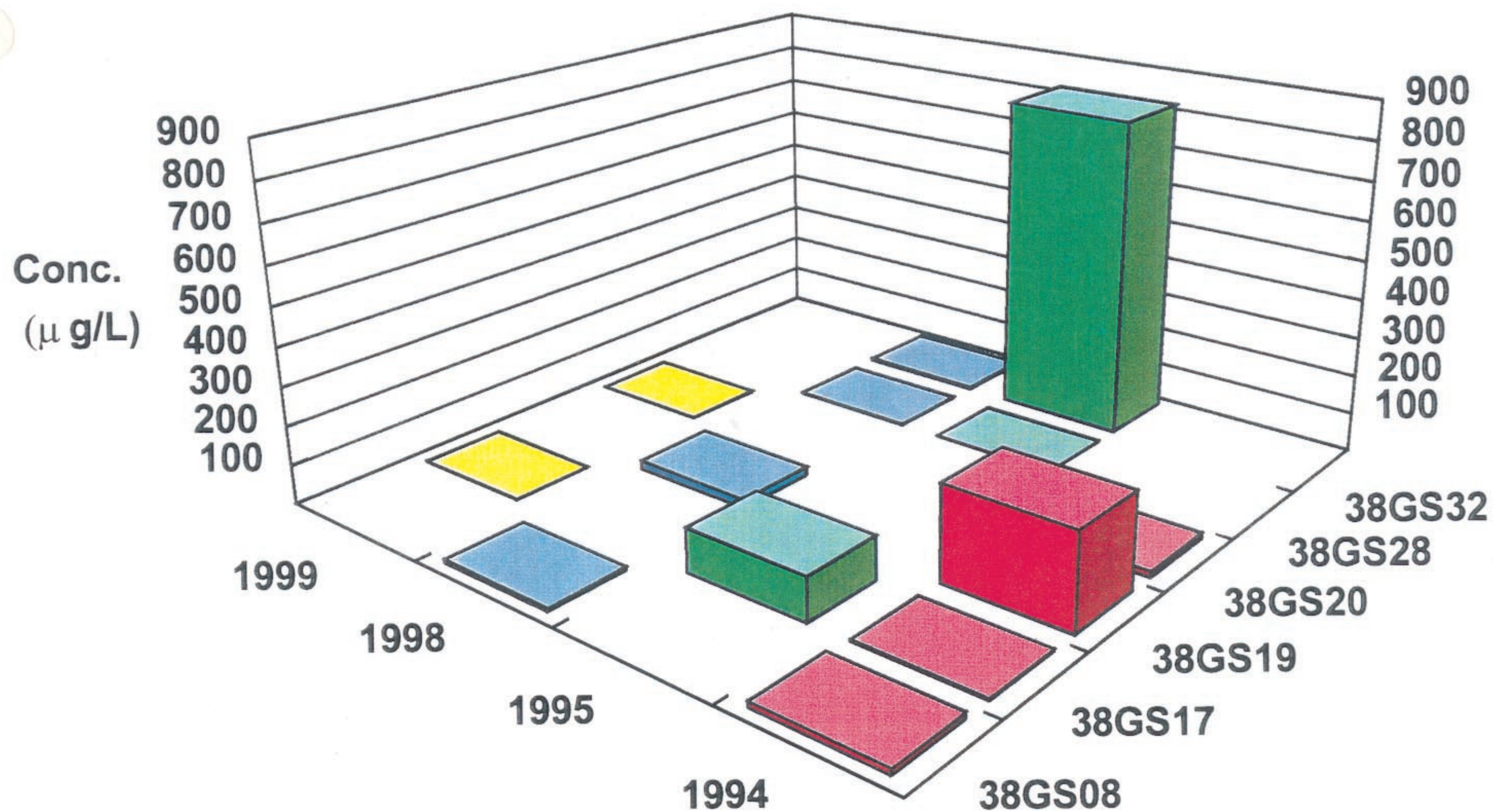


Figure 5.10 Trichloroethene Building 604 Well Concentrations

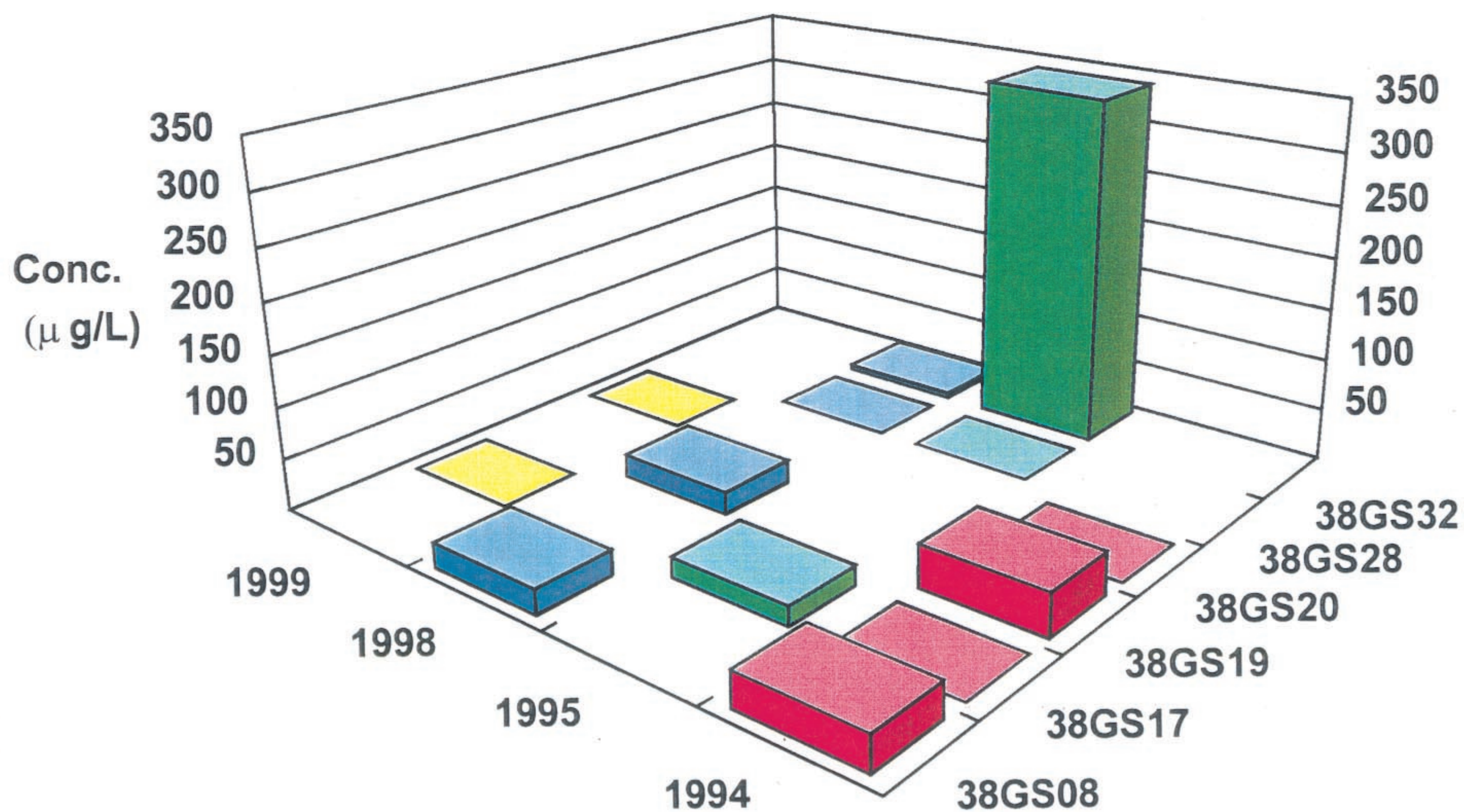


Figure 5.11 cis-1,2 -Dichloroethene Building 604 Well Concentrations

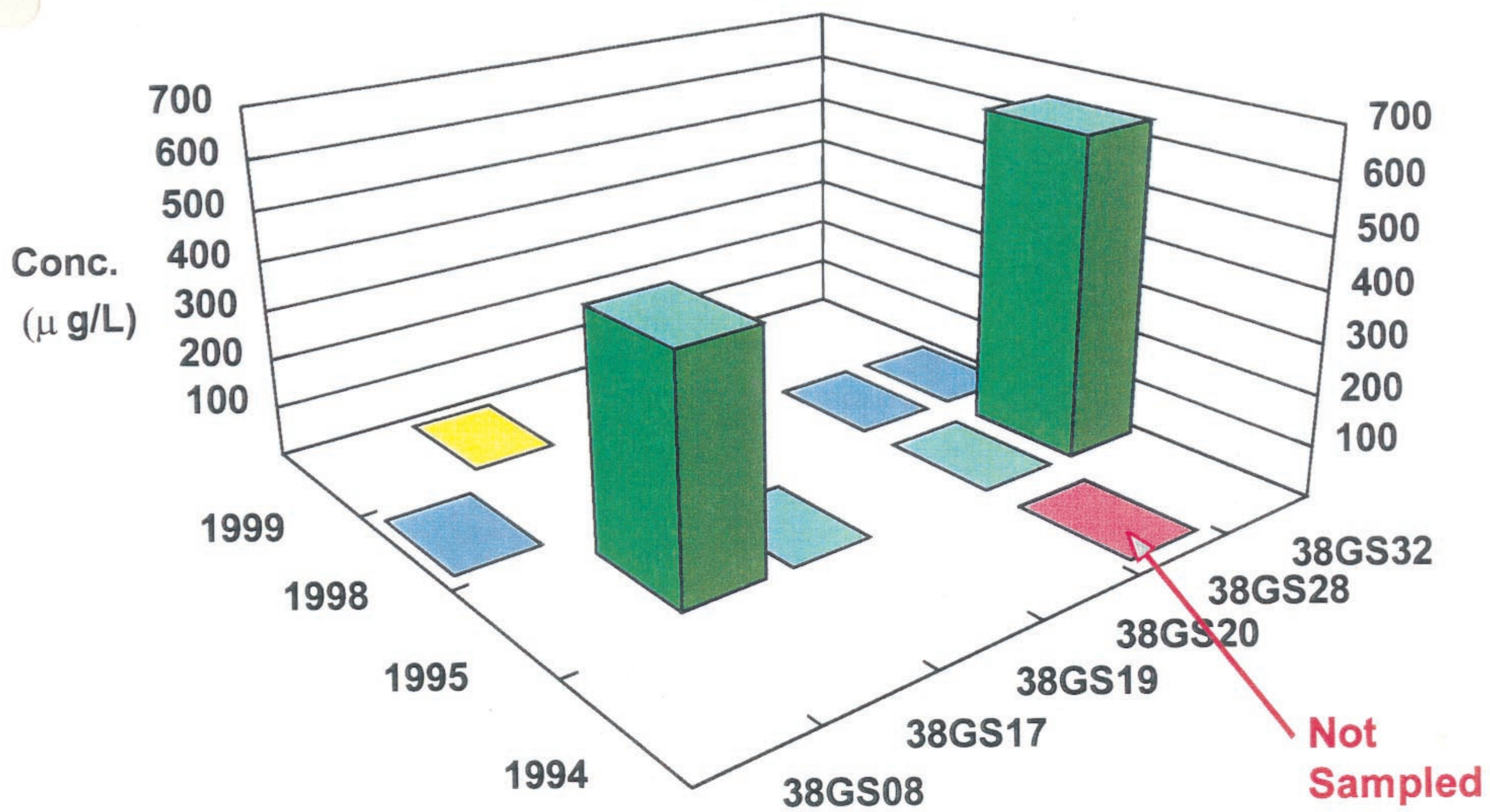


Figure 5.12 1,1-Dichloroethane Building 604 Well Concentrations

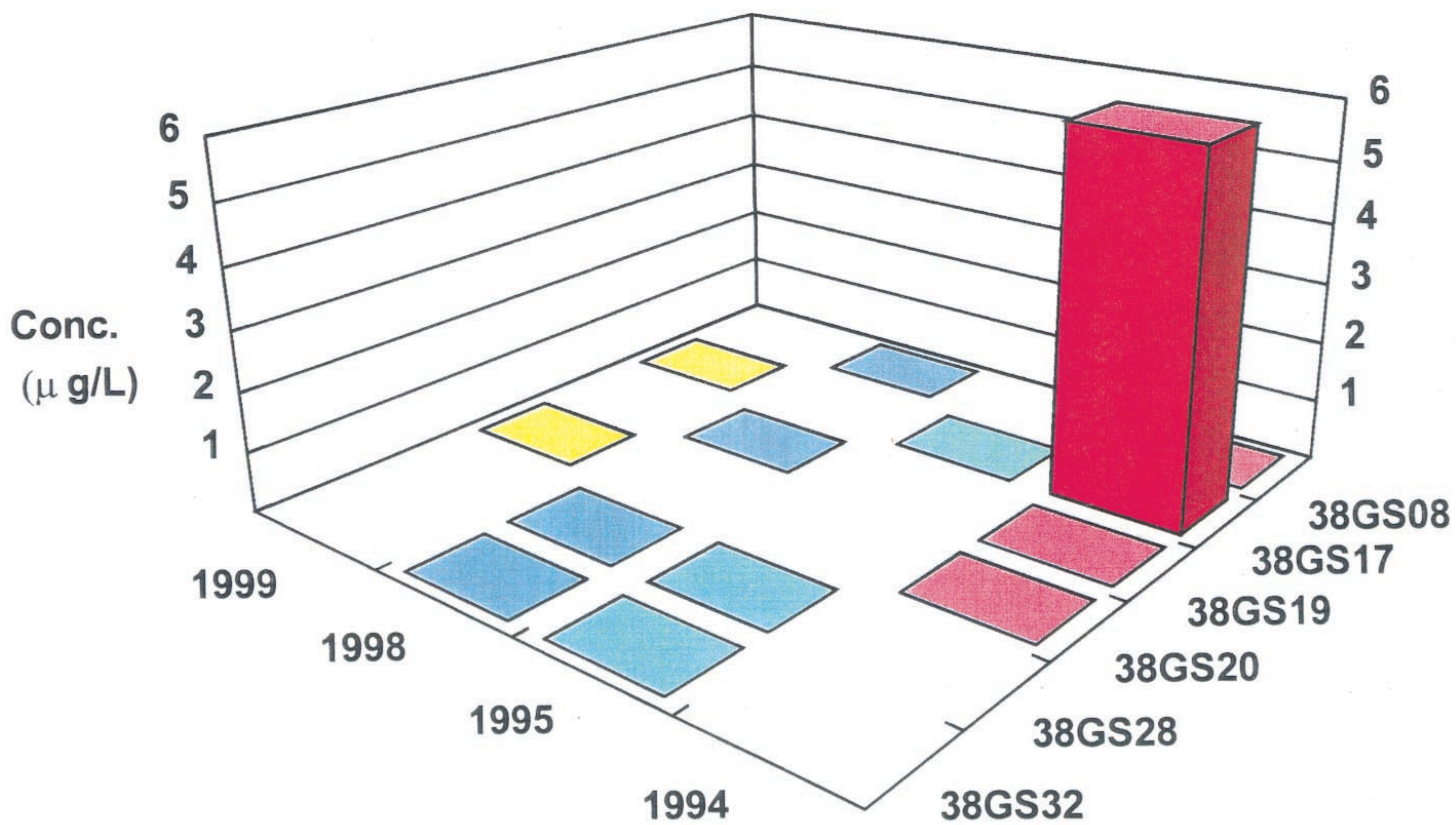


Figure 5.13 1994 Bldg. 604 Natural Attenuation of Chlorinated Solvents in Groundwater at NAS Pensacola

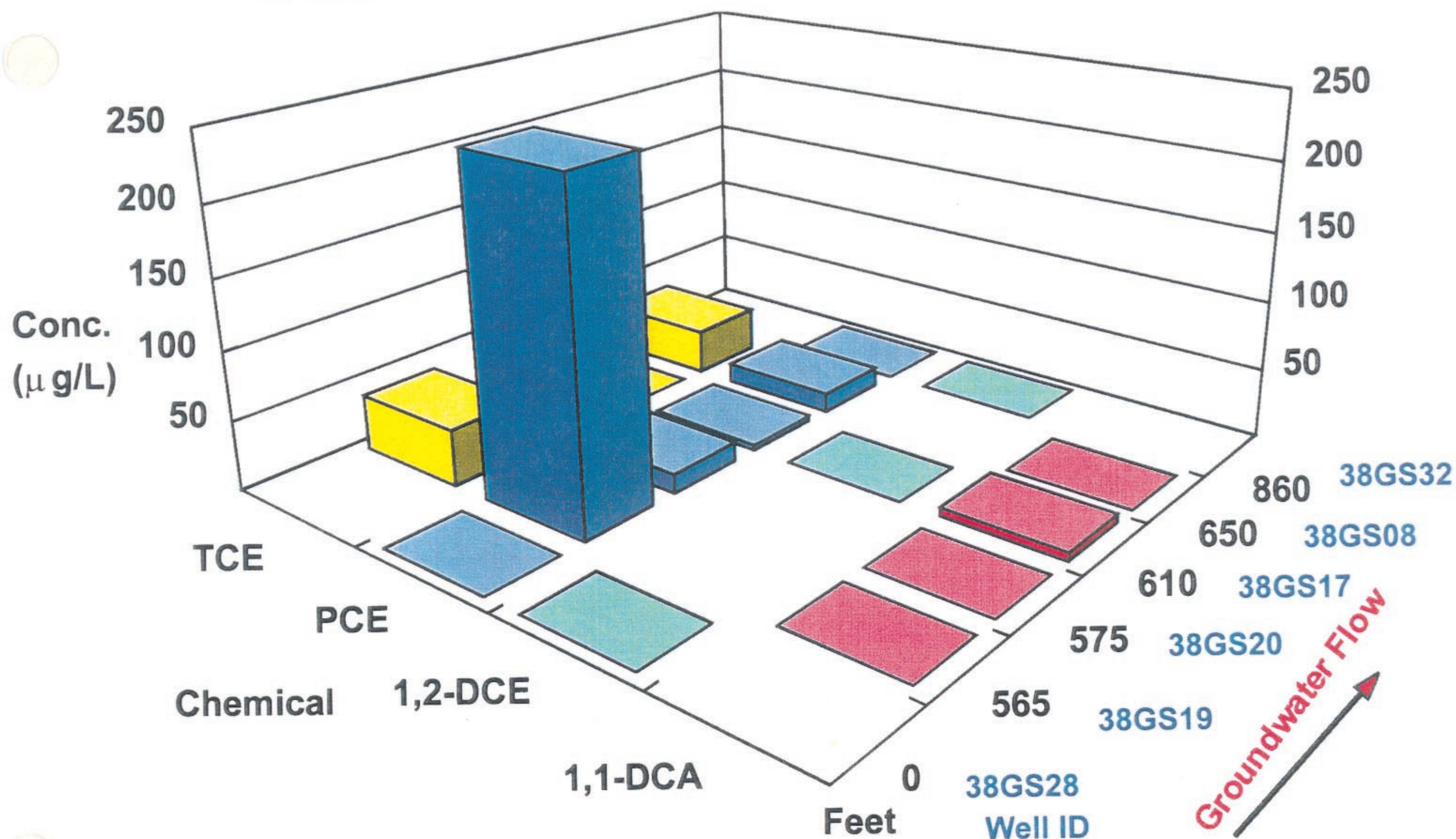


Figure 5.14 1995 Bldg. 604 Natural Attenuation Chlorinated Solvents in Groundwater at NAS Pensacola

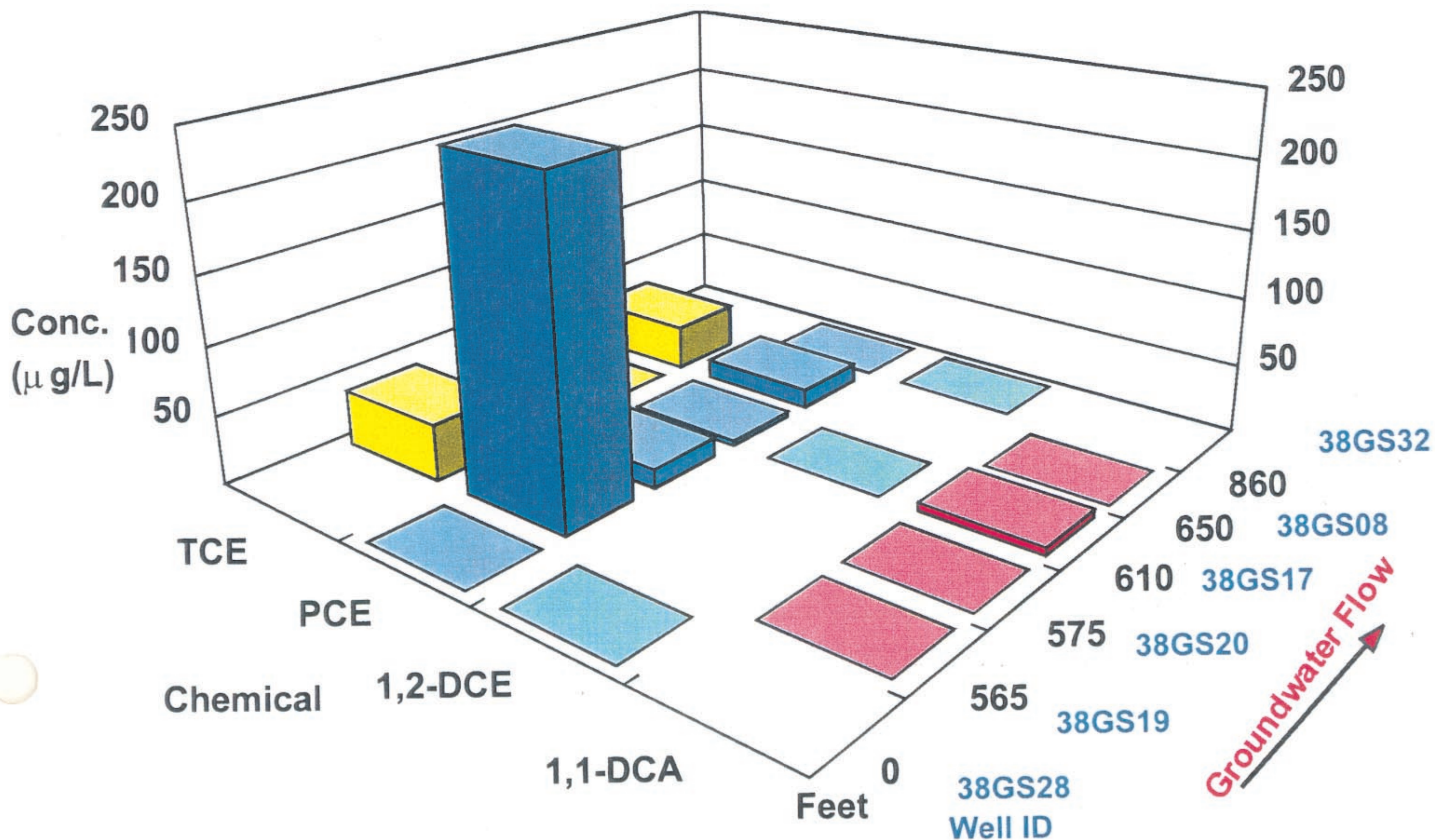


Figure 5.15 1998 Bldg. 604 Natural Attenuation of Chlorinated Solvents in Groundwater at NAS Pensacola

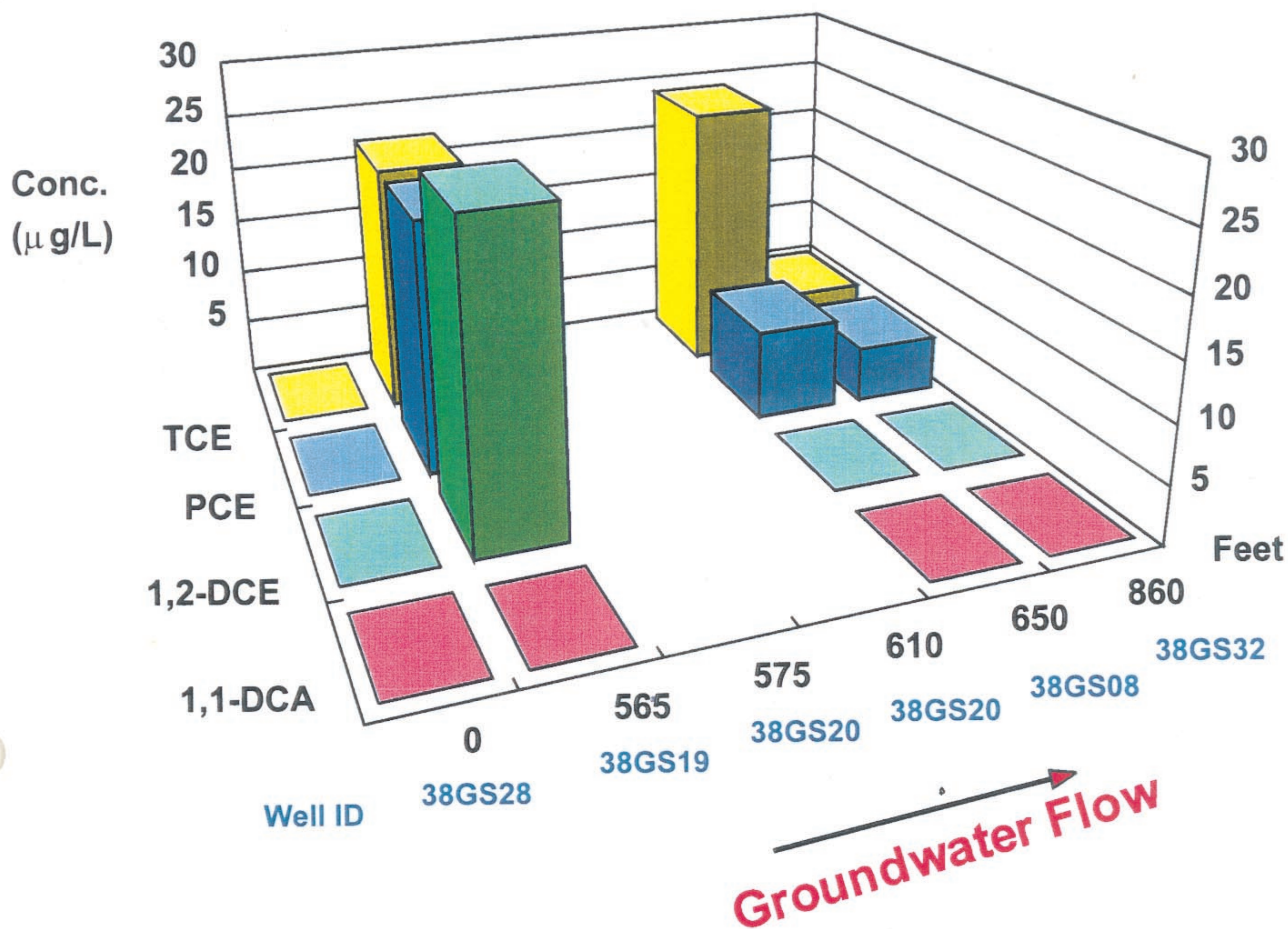


Table 5.4
 Site 38 — 1994-1999
 Historical Data for Chlorinated Solvents
 Detected in Groundwater at Building 604

Parameter	Location	RI Samples (Jan 1994)	EPA Samples (Oct 1995)	Samples (Dec 1998)	Samples (May 1999)	Screening Concentration	Screening Source
Volatile Organic Compounds ($\mu\text{g/L}$)							
1,1-Dichloroethane	38GS08	ND	NS	ND	NS	700	FGGC
	38GS17	6	ND	NS	ND		
	38GS19	ND	NS	ND	NS		
	38GS20	ND	NS	NS	ND		
	38GS28	NS	ND	ND	NS		
	38GS32	NS	ND	ND	NS		
cis-1,2-Dichloroethene	38GS08	NA	NS	25	NS	70	FPDWS
	38GS17	NA	460	NS	ND		
	38GS19	NA	NS	27	NS		
	38GS20	NA	NS	NS	ND		
	38GS28	NS	ND	ND	NS		
	38GS32	NS	640	25	NS		
Tetrachloroethene	38GS08	14	NS	8	NS	3	FPDWS
	38GS17	4	110	NS	ND		
	38GS19	240	NS	22	NS		
	38GS20	14	NS	NS	ND		
	38GS28	NS	ND	ND	NS		
	38GS32	NS	820	5	NS		
Trichloroethene	38GS08	33	NS	24	NS	3	FPDWS
	38GS17	ND	19	NS	ND		
	38GS19	41	NS	22	NS		
	38GS20	ND	NS	NS	ND		
	38GS28	NS	ND	ND	NS		
	38GS32	NS	340	5	NS		

Table 5.4
 Site 38 — 1994-1999
 Historical Data for Chlorinated Solvents
 Detected in Groundwater at Building 604

Parameter	Location	RI Samples (Jan 1994)	EPA Samples (Oct 1995)	Samples (Dec 1998)	Samples (May 1999)	Screening Concentration	Screening Source
Vinyl Chloride	38GS08	6	NS	ND	NS	1	FPDWS
	38GS17	1,600	3,700	NS	ND		
	38GS19	29	NS	3	NS		
	38GS20	1,100	NS	NS	15		
	38GS28	NS	NS	ND	NS		
	38GS32	NS	130	14	NS		

Notes:

ND — Parameter not detected in this sample.
 NA — Parameter not analyzed for this sample.
 NS — Well not sampled during this event.
 Concentrations exceeding screening values are in bold.

5.2 Effect of Geochemistry on Lead Concentrations

5.2.1 Building 71 Area

Lead concentrations have decreased over the entire site since sampling began in 1994 (see Table 5.5 below). All three downgradient wells (38GS02, 38GS03, and 38GS10) are now at non-detect concentrations. Furthermore, the concentration of lead in 38GS12, the most contaminated well, has also decreased from 280 $\mu\text{g/L}$ to 128 $\mu\text{g/L}$ in three years.

Table 5.5
Lead Concentrations ($\mu\text{g/L}$) in Groundwater
Buildings 71 and 604
1994-1998

Bldg 71	RI Samples	EPA Samples	Addendum Samples
Location	(Jan 1994)	(Oct 1995)	(December 1998)
38GS01	276	NS	117
38GS02	362	NS	ND
38GS03	388.5	NS	ND
38GS10	54	NS	ND
38GS12	280	NS	128

Bldg 604	RI Samples	EPA Samples	Addendum Samples
Location	(Jan 1994)	(Oct 1995)	(December 1998)
38GS28		ND	4
38GS08	79.2	NS	116
38GS17	65.2	ND	NS
38GS19	180	NS	58
38GS20	110	NS	NS
38GS32	ND	NS	24

The decrease in Area 71 lead concentrations can be linked to site geochemistry and the presence of sulfate, sulfide, and the overwhelming evidence of sulfate-reducing conditions in the aquifer. The presence of sulfide in sufficient quantities results in the ready precipitation of lead to form lead sulfide (PbS). This precipitation immobilizes the metal and is an effective natural mechanism for remediation.

5.2.2 Building 604 Area

Lead concentrations have decreased at locations 38GS17 and 38GS19 (see Table 5.5). Concentrations are now at non-detect at 38GS17. This is most likely due to the sulfate present in the groundwater and the conversion of sulfates to sulfide under anaerobic conditions, as indicated by hydrogen measurements, ORP values, and sulfide concentrations.

Though concentrations of lead have increased temporarily at downgradient wells 38GS08 and 38GS32, it is likely that they will decrease over time. Hydraulically upgradient groundwater wells now exhibit sulfate-reducing conditions that are likely to immobilize the lead. With increasing immobilization of lead and reduced concentrations in the upgradient locations, lead in the downgradient groundwater is likely to gradually follow the same pattern of decreasing concentrations over time. This hypothesis is supported by the general anaerobic nature of the aquifer and the presence of sufficient amounts of sulfate to provide the sulfide required for lead precipitation. However, this hypothesis will have to be verified through monitoring.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

- Geochemical analysis and interpretation of groundwater results at Site 38 show that both Building 71 and 604 Areas are highly conducive to natural biological degradation of chlorinated solvents.
- Measurements of DO, ORP, hydrogen, and other geochemical parameters have established anaerobic or reducing conditions in the aquifer, which are critical for reductive dechlorination of chlorinated solvents.
- Geochemical analysis has shown evidence to suggest the continuing degradation of PCE and TCE.
- Low concentrations of vinyl chloride at Site 38 suggest that this critical biological daughter breakdown product is not accumulating in the aquifer.
- Historical trends show an overall decrease in concentrations of PCE and TCE across these two areas and an overall decrease along the direction of groundwater flow.
- Lead concentrations at the site have decreased over time in critical locations in both areas, which is attributed to favorable geochemical conditions in the aquifer. Although lead concentrations have temporarily increased at two downgradient locations in the Building 604 Area, conditions are still favorable for an overall decrease in lead via precipitation before it is transported to downgradient locations.

6.2 Recommendations

Based on overwhelming evidence of natural biological degradation of chlorinated solvents in the aquifer and the decrease in contaminant concentrations observed over time, it is recommended that MNA be considered as the potential remedial alternative for Site 38. This would necessitate implementing a groundwater monitoring program or a performance monitoring program to verify natural attenuation is occurring (US EPA, November, 1997). The purpose of the monitoring program will be to:

- Demonstrate continuing natural biological degradation in the aquifer.
- Document continued decreases in concentrations over time.
- Ensure that downgradient receptors are not unduly impacted.
- Ensure that daughter products are not accumulating in the aquifer.
- Verify the attainment of cleanup objectives.
- Trigger the implementation of alternate active (engineered) remedies, if MNA does not fulfill the cleanup objectives.

Performance monitoring during remedial design will initially include collection of two more rounds of groundwater samples to complete the evaluation of seasonal effects (four different quarters) on site geochemistry and MNA feasibility. Following this final evaluation, the frequency and duration of long-term monitoring will be determined during remedial implementation.

Performance monitoring would continue as long as contamination remains above cleanup goals. It is performed at a specified frequency, usually annually. Monitoring is typically performed for a specified period of time after cleanup objectives are attained (one to three years). The data collected during performance monitoring will be used to update contaminant trend graphs and confirm continued decreases in concentration in the direction of groundwater flow. When sufficient data are available, the feasibility and reliability of estimating degradation rates and cleanup times will be examined. Wells in the monitoring program would include those located where contamination still exists and locations downgradient of the contaminated areas. Cleanup goals and the monitoring plan are outlined in the Site 38 FS Report. If MNA is accepted as the remedy for Site 38, a detailed monitoring plan will be submitted for approval and implementation during remedial design.

7.0 REFERENCES

USEPA. *Draft EPA Region 4 Suggested Practices for Evaluation of a Site for Natural Attenuation (Biological Degradation) of Chlorinated Solvents*. November 1997.

USEPA. *Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites. Directive 92000.4-17*. November, 1997.

USEPA. *Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water*. EPA 600/R/R-98/128, Office of Research and Development, Washington DC. September 1998.

This glossary has been taken from *Natural Attenuation of Chlorinated Solvents in Groundwater: Principles And Practices*, Version 3.0 May 1997, prepared by the Bioremediation of Chlorinated Solvents Consortium of the Remediation Technologies Development Forum (RTDF).

Abiotic: Occurring without the involvement of microorganisms.

Advection: Transport of molecules dissolved in water along the groundwater flow path at an average expected velocity.

Aerobic Respiration: Process whereby microorganisms use oxygen as an electron acceptor to generate energy.

Aliphatic Hydrocarbon: A compound built from carbon and hydrogen atoms joined in a linear chain. Petroleum products are composed primarily of aliphatic hydrocarbons.

Anaerobic Respiration: Process whereby microorganisms use a chemical other than oxygen as an electron acceptor. Common "substitutes" for oxygen are nitrate, sulfate, iron, carbon dioxide, and other organic compounds (fermentation).

Aquifer: An underground geological formation that stores groundwater.

Aquitard: An underground geological formation of low permeability that does not readily transmit groundwater.

Aromatic Hydrocarbon: A compound built from carbon and hydrogen atoms joined in an unsaturated ring (e.g., benzene ring).

Bacterium: A single cell organism of microscopic size. Bacteria are ubiquitous in the environment, inhabiting water, soil, organic matter and the bodies of plants and animals.

Biodegradation: Biologically mediated conversion of one compound to another.

Biomass: Total mass of microorganisms present in a given amount of water or soil.

Bioremediation: Use of microorganisms to control and destroy contaminants.

Biotransformation: Microbiologically catalyzed transformation of a chemical to some other product.

Chlorinated Solvent: A hydrocarbon in which chlorine atoms substitute for one or more hydrogen atoms in the compounds structure. Chlorinated solvents commonly are used for grease removal in manufacturing, dry cleaning, and other operations.

Cometabolism: A reaction in which microbes transform a contaminant even though the contaminant cannot serve as an energy source for the organisms. To degrade the contaminant, the microbes require the presence of other compounds (primary substrates) that can support their growth.

Degradation: Destruction of a compound through biological or abiotic reactions.

Dechlorination: The removal of chlorine atoms from a compound.

Desorption: Opposite of sorption; the release of chemicals attached to solid surfaces.

Diffusion: Dispersive process that results from the movement of molecules along a concentration gradient. Molecules move from areas of high concentration to low concentration.

Dilution: The combined processes of advection and dispersion result in a net dilution of the molecules in the groundwater.

Dispersion: The spreading of molecules along and away from the expected groundwater flow path during advection as a result of mixing of groundwater in individual pores and channels.

Electron: A negatively charged subatomic particle that may be transferred between chemical species in chemical reactions. Every chemical molecule contains electrons and protons (positively charged particles).

Electron Acceptor: Compound that gains electrons (and therefore is reduced) in oxidation – reduction reactions that are essential for the growth of microorganisms. Common electron acceptors are oxygen, nitrate, sulfate, iron and carbon dioxide. Highly chlorinated solvents (e.g., TCE) can act as electron acceptors.

Electron Donor: Compound that loses electrons (and therefore is oxidized) in oxidation – reduction reactions that are essential for the growth of microorganisms. In bioremediation organic compounds serve as electron donors. Less chlorinated solvents (e.g., VC) can act as electron donors.

Hydraulic Conductivity: A measure of the rate at which water moves through a unit area of the subsurface under a unit hydraulic gradient.

Hydraulic Gradient: Change in head (i.e., water pressure) per unit distance in a given direction, typically in the principal flow direction.

Inorganic Compound: A chemical that is not based on covalent carbon bonds. Important examples are metals, nutrients such as nitrogen and phosphorus, minerals, and carbon dioxide.

Intrinsic Bioremediation: A type of in situ bioremediation that uses the innate capabilities of naturally occurring microbes to degrade contaminants without taking any engineering steps to enhance the process.

Metabolic Intermediate: A chemical produced by one step in a multistep biotransformation.

Metabolism: The chemical reactions in living cells that convert food sources to energy and new cell mass.

Methanogen: A microorganism that exists in anaerobic environments and produces methane as the end product of its metabolism. Methanogens use carbon dioxide or simple carbon compounds such as methanol as an electron acceptor.

Microcosm: A laboratory vessel set up to resemble as closely as possible the conditions of a natural environment.

Microorganism: An organism of microscopic or submicroscopic size. Bacteria are microorganisms.

Mineralization: The complete degradation of an organic chemical to carbon dioxide, water, and in some cases inorganic ions.

Oxidization: Loss of electrons from a compound, such as an organic contaminant. The oxidation can supply energy that microorganisms use for growth. Often (but not always), oxidation results in the addition of an oxygen atom and/or the loss of a hydrogen atom.

Petroleum Hydrocarbon: A chemical derived from petroleum by various refining processes. Examples include gasoline, fuel oil and a wide range of chemicals used in manufacturing and industry.

Plume: A zone of dissolved contaminants. A plume usually originates from a source and extends for some distance in the direction of ground water flow.

Primary Substrates: The electron donor and electron acceptor that are essential to ensure the growth of microorganisms. These compounds can be viewed as analogous to the food and oxygen that are required for human growth.

Reduction: Transfer of electrons to a compound such as oxygen. It occurs when another compound is oxidized.

Reductive Dehalogenation: A variation on biodegradation in which microbially catalyzed reactions cause the replacement of a halogen atom (e.g., chlorine) on an organic compound with a hydrogen atom. The reactions result in the net addition of two electrons to the organic compound.

Saturated Zone: Subsurface environments where pore spaces are filled with water.

Sorption: Attachment of a substance on the surface of a solid by physical or chemical attraction.

Stabilization: Process whereby chemical molecules become chemically bound by a stabilizing agent (e.g., clay, humic materials), reducing the mobility of the molecule in the groundwater.

Substrate: A compound that microorganisms can use in the chemical reactions catalyzed by their enzymes.

Sulfate reducer: A microorganism that exists in anaerobic environments and reduces sulfate to hydrogen sulfide.

Surface to Volume Ratio: The surface area of an object relative to its volume.

Unsaturated Zone: Soil above the water table, where pores are partially or largely filled with air.

Vadose Zone: See "Unsaturated Zone."

Volatilization: Transfer of a chemical from the liquid to the gas phase (as in evaporation).

Appendix B
USEPA MNA Protocol

Table 2.1 Soil, Soil Gas, and Ground-water Analytical Methods to Evaluate the Potential for Natural Attenuation of Chlorinated Solvents or Fuel Hydrocarbons in Ground Water. Analyses other than those listed in this table may be required for regulatory compliance.

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Soil	Aromatic and Chlorinated hydrocarbons (benzene, toluene, ethylbenzene, and xylene [BTEX]; Chlorinated Compounds	SW8260A		Data are used to determine the extent of soil contamination, the contamination mass present, and the potential for source removal.	Each soil sampling round	Sample volume approximately 100 ml; subsample and extract in the field using methanol or appropriate solvent; cool to 4°C.	Fixed-base
Soil	Biologically Available Iron (III)	Under development	HCl extraction followed by quantification of released iron (III)	Optional method that should be used when fuel hydrocarbons or vinyl chloride are present in the ground water to predict the possible extent of removal of fuel hydrocarbons and vinyl chloride via iron reduction.	One round of sampling in five borings, five cores from each boring	Minimum 1 inch diameter core samples collected into plastic liner. Cap and prevent aeration.	Laboratory
Soil	Total organic carbon (TOC)	SW9060 modified for soil samples	Procedure must be accurate over the range of 0.1 to 5 percent TOC	The rate of migration of petroleum contaminants in ground water is dependent upon the amount of TOC in the aquifer matrix.	At initial sampling	Collect 100 g of soil in a glass container with Teflon-lined cap; cool to 4°C.	Fixed-base
Soil Gas	Fuel and Chlorinated VOCs	EPA Method TO-14		Useful for determining chlorinated and BTEX compounds in soil	At initial sampling	1-liter Summa Canister	Fixed-base
Soil Gas	Methane, Oxygen, Carbon dioxide	Field Soil Gas Analyzer		Useful for determining bioactivity in vadose zone.	At initial sampling and respiration testing	3-liters in a Tedlar bag, bags are reusable for analysis of methane, oxygen, or carbon dioxide.	Field

Table 2.1 (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Alkalinity	Hach Alkalinity test kit model AL AP MG-L	Phenolphthalein method	General water quality parameter used (1) as a marker to verify that all site samples are obtained from the same ground-water system and (2) to measure the buffering capacity of ground water.	Each sampling round	Collect 100 mL of water in glass container.	Field
Water	Aromatic and chlorinated hydrocarbons (BTEX, trimethylbenzene isomers, chlorinated compounds)	SW8260A	Analysis may be extended to higher molecular weight alkyl benzenes	Method of analysis for BTEX and chlorinated solvents/byproducts, which are the primary target analytes for monitoring natural attenuation; method can be extended to higher molecular weight alkyl benzenes; trimethylbenzenes are used to monitor plume dilution if degradation is primarily anaerobic.	Each sampling round	Collect water samples in a 40 mL VOA vial; cool to 4°C; add hydrochloric acid to pH 2.	Fixed-base
Water	Arsenic	EPA 200.7 or EPA 200.9		To determine if anaerobic biological activity is solubilizing arsenic from the aquifer matrix material.	One round of sampling	Collect 100 ml in a glass or plastic container that is rinsed in the field with the ground water to be sampled. Unfiltered samples obtained using low flow sampling methods are preferred for analysis of dissolved metals. Adjust pH to 2 with nitric acid. Do not insert pH paper or an electrode into the sample.	Laboratory
Water	Chloride (optional, see data use)	Hach Chloride test kit model 8-P	Silver nitrate titration	As above, and to guide selection of additional data points in real time while in the field.	Each sampling round	Collect 100 mL of water in a glass container.	Field

Table 2.1 (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Chloride	Mercuric nitrate titration A4500-Cl ⁻ C	Ion chromatography (IC) method E300 or method SW9050 may also be used	General water quality parameter used as a marker to verify that site samples are obtained from the same ground-water system. Final product of chlorinated solvent reduction.	Each sampling round	Collect 250 mL of water in a glass container.	Fixed-base
Water	Chloride (optional, see data use)	Hach Chloride test kit model 8-P	Silver nitrate titration	As above, and to guide selection of additional data points in real time while in the field.	Each sampling round	Collect 100 mL of water in a glass container.	Field
Water	Conductivity	E120.1/SW9050, direct reading meter		General water quality parameter used as a marker to verify that site samples are obtained from the same ground-water system.	Each sampling round	Collect 100 to 250 mL of water in a glass or plastic container.	Field
Water	Iron (II) (Fe ⁺²)	Colorimetric Hach Method # 8146	Filter if turbid.	May indicate an anaerobic degradation process due to depletion of oxygen, nitrate, and manganese.	Each sampling round	Collect from a flow-through or over-flow cell / analyze at the well head.	Field
Water	Hydrogen (H ₂)	Equilibration with gas in the field. Determined with a reducing gas detector.	Optional specialized analysis	Determined terminal electron accepting process. Predicts the possibility for reductive dechlorination.	One round of sampling on selected wells.	Sampled at well head requires the production of 300 mL per minute of water for 30 minutes.	Field
Water	Manganese	EPA 200.7 or EPA 200.9		To determine if anaerobic biological activity is solubilizing manganese from the aquifer matrix material.	One round of sampling	Collect 100 ml in a glass or plastic container that is rinsed in the field with the ground water to be sampled. Unfiltered samples obtained using low flow sampling methods are preferred for analysis of dissolved metals. Adjust pH to 2 with nitric acid. Do not insert pH paper or an electrode into the sample.	Laboratory

Table 2.1 (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Methane, ethane, and ethene	Kampbell <i>et al.</i> , 1989 and 1998 or SW3810 Modified	Method published by researchers at the U.S. Environmental Protection Agency. Limited to few commercial labs.	The presence of CH ₄ suggests BTEX degradation via methanogenesis. Ethane and ethene data are used where chlorinated solvents are suspected of undergoing biological transformation.	Each sampling round	Collect water samples in 50 mL glass serum bottles with gray butyl /Teflon-faced septa and crimp caps; add H ₂ SO ₄ to pH less than 2, cool to 4°C.	Fixed-base
Water	Nitrate	IC method E300		Substrate for microbial respiration if oxygen is depleted.	Each sampling round	Collect up to 40 mL of water in a glass or plastic container; add H ₂ SO ₄ to pH less than 2, cool to 4°C.	Fixed-base
Water	Oxidation-reduction potential	A2580B	Measurements made with electrodes; results are displayed on a meter; protect samples from exposure to oxygen. Report results against a silver/silver chloride reference electrode. (Eh) is calculated by adding a correction factor specific to the electrode used.	The ORP of ground water influences and is influenced by the nature of the biologically mediated degradation of contaminants; the ORP (expressed as Eh) of ground water may range from more than 800 mV to less than -400 mV.	Each sampling round	Measure in a flow through cell or an over-flowing container filled from the bottom to prevent exposure of the ground water to the atmosphere.	Field
Water	Oxygen	Dissolved oxygen meter calibrated between each well according to the supplier's specifications	Refer to method A4500 for a comparable laboratory procedure.	The oxygen concentration is a data input to the Bioplume model; concentrations less than 1 mg/L generally indicate an anaerobic pathway.	Each sampling round	Measure dissolved oxygen on site using a flow-through cell or over-flow cell.	Field
Water	pH	Field probe with direct reading meter calibrated in the field according to the supplier's specifications.	Field	Aerobic and anaerobic biological processes are pH-sensitive.	Each sampling round	Measure dissolved oxygen on site using a flow-through cell or over-flow cell.	Field

Table 2.1 (Continued)

Matrix	Analysis	Method/Reference	Comments	Data Use	Recommended Frequency of Analysis	Sample Volume, Sample Container, Sample Preservation	Field or Fixed-Base Laboratory
Water	Sulfate (SO_4^{2-})	IC method E300	If this method is used for sulfate analysis, do not use the field method.	Substrate for anaerobic microbial respiration.	Each sampling round	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C.	Fixed-base
Water	Sulfate (SO_4^{2-})	Hach method # 8051	Colorimetric, if this method is used for sulfate analysis, do not use the fixed-base laboratory method.	Same as above.	Each sampling round	Collect up to 40 mL of water in a glass or plastic container; cool to 4°C.	Field
Water	Temperature	Field probe with direct reading meter.	Field only	To determine if a well is adequately purged for sampling.	Each sampling round	Read from oxygen meter.	Field
Water	Total Organic Carbon also called DOC	SW9060	Laboratory	Used to classify plume and to determine if reductive dechlorination is possible in the absence of anthropogenic carbon.	Each sampling round	Measure using a flow-through cell or over-flow cell.	Laboratory

NOTES:

1. "Hach" refers to the Hach Company catalog, 1990.
2. "A" refers to *Standard Methods for the Examination of Water and Wastewater*, 18th edition, 1992.
3. "E" refers to *Methods for Chemical Analysis of Water and Wastes*, U.S. EPA, 1983.
4. "SW" refers to the *Test Methods for Evaluating Solid Waste, Physical, and Chemical Methods*, SW-846, U.S. EPA, 3rd edition, 1986.

Table 2.2 Objectives for Sensitivity and Precision to Implement the Natural Attenuation Protocol. Analyses other than those listed in this table may be required for regulatory compliance.

Matrix	Analysis	Method/Reference	Minimum Limit of Quantification	Precision	Availability	Potential Data Quality Problems
Soil	Aromatic and chlorinated hydrocarbons (benzene, toluene, ethylbenzene, and xylene [BTEX]; chlorinated compounds)	SW8260A	1 mg/Kg	Coefficient of Variation of 20 percent.	Common laboratory analysis.	Volatiles lost during shipment to laboratory; prefer extraction in the field.
Soil	Biologically Available Iron (III)	Under development	50 mg/Kg	Coefficient of Variation of 40 percent.	Specialized laboratory analysis.	Sample must not be allowed to oxidize.
Soil	Total organic carbon (TOC)	SW9060 modified for soil samples	0.1 percent	Coefficient of Variation of 20 percent.	Common laboratory analysis.	Samples must be collected from contaminant-transporting (i.e., transmissive) intervals.
Soil Gas	Fuel and Chlorinated VOCs	EPA Method TO-14	1 ppm (volume/volume)	Coefficient of Variation of 20 percent.	Common laboratory analysis.	Potential for atmospheric dilution during sampling.
Soil Gas	Methane, O ₂ , CO ₂	Field Soil Gas Analyzer	1 percent (volume/volume)	Coefficient of Variation of 20 percent.	Readily available field instrument.	Instrument must be properly calibrated.
Water	Alkalinity	Hach alkalinity test kit model AL AP MG-L	50 mg/L	Standard deviation of 20 mg/L.	Common field analysis.	Analyze sample within 1 hour of collection.
Water	Aromatic and chlorinated hydrocarbons (BTEX, trimethylbenzene isomers, chlorinated compounds)	SW8260A	MCLs	Coefficient of Variation of 10 percent.	Common laboratory analysis.	Volatilization during shipment and biodegradation due to improper preservation.
Water	Chloride	IC method E300	1 mg/L	Coefficient of Variation of 20 percent.	Common laboratory analysis.	---
Water	Chloride (optional, see data use)	Hach Chloride test kit model 8-P	1 mg/L	Coefficient of Variation of 20 percent.	Common field analysis.	Possible interference from turbidity.
Water	Conductivity	E120.1/SW9050, direct reading meter	50 $\mu\text{S}/\text{cm}^2$	Standard deviation of 50 $\mu\text{S}/\text{cm}^2$.	Common field probe.	Improperly calibrated instrument.

Table 2.2 (Continued)

Matrix	Analysis	Method/Reference	Minimum Limit of Quantification	Precision	Availability	Potential Data Quality Problems
Water	Hydrogen (H ₂) ^u	See Appendix A	0.1 nM	Standard deviation of 0.1nM.	Specialized field analysis.	Numerous, see Appendix A.
Water	Iron (II) (Fe ²⁺) XX	Colorimetric Hach Method # 8146	0.5 mg/L	Coefficient of Variation of 20 percent.	Common field analysis.	Possible interference from turbidity (must filter if turbid). Keep out of sunlight and analyze within minutes of collection.
Water	Major Cations	SW6010	1 mg/L	Coefficient of Variation of 20 percent.	Common laboratory analysis.	Possible colloidal interferences.
Water	Methane, ethane, and ethene	Kampbell <i>et al.</i> , 1989 or SW3810 Modified	1 µg/L	Coefficient of Variation of 20 percent.	Specialized laboratory analysis.	Sample must be preserved against biodegradation and collected without headspace (to minimize volatilization).
Water	Nitrate	IC method E300	0.1 mg/L	Standard deviation of 0.1 mg/L	Common laboratory analysis.	Must be preserved.
Water	Oxidation-reduction potential (ORP)	A2580B	plus or minus 300 mV	plus or minus 50 mV.	Common field probe.	Improperly calibrated electrodes or introduction of atmospheric oxygen during sampling.
Water	Oxygen	Dissolved oxygen meter	0.2 mg/L	Standard deviation of 0.2 mg/L.	Common field instrument.	Improperly calibrated electrodes or bubbles behind the membrane or a fouled membrane or introduction of atmospheric oxygen during sampling.
Water	Sulfate (SO ₄ ²⁻)	IC method E300	5 mg/L	Coefficient of Variation of 20 percent.	Common laboratory.	Fixed-base.
Water	Sulfate (SO ₄ ²⁻) XX	Hach method # 8051	5 mg/L	Coefficient of Variation of 20 percent.	Common field analysis.	Possible interference from turbidity (must filter if turbid). Keep sample cool.
Water	pH	Field probe with direct reading meter.	0.1 standard units	0.1 standard units.	Common field meter.	Improperly calibrated instrument; time sensitive.
Water	Temperature	Field probe with direct reading meter.	0 degrees Celsius	Standard deviation of 1 degrees Celsius.	Common field probe.	Improperly calibrated instrument; time sensitive.
Water	Total Organic Carbon	SW9060	0.1 mg/L	Coefficient of Variation of 20 percent.	Common laboratory analysis.	

Notes:

** Filter if turbidity gives a response from the photometer before addition of the reagents that is as large or larger than the specified minimum quantification limit.

Table 2.3 Analytical Parameters and Weighting for Preliminary Screening for Anaerobic Biodegradation Processes^{a/}

Analysis	Concentration in Most Contaminated Zone	Interpretation	Value
Oxygen*	<0.5 mg/L	Tolerated, suppresses the reductive pathway at higher concentrations	3
Oxygen*	>5 mg/L	Not tolerated; however, VC may be oxidized aerobically	-3
Nitrate*	<1 mg/L	At higher concentrations may compete with reductive pathway	2
Iron II*	>1 mg/L	Reductive pathway possible; VC may be oxidized under Fe(III)-reducing conditions	3
Sulfate*	<20 mg/L	At higher concentrations may compete with reductive pathway	2
Sulfide*	>1 mg/L	Reductive pathway possible	3
Methane*	<0.5 mg/L	VC oxidizes	0
	>0.5 mg/L	Ultimate reductive daughter product, VC Accumulates	3
Oxidation Reduction Potential* (ORP) against Ag/AgCl electrode	<50 millivolts (mV)	Reductive pathway possible	1
	<-100mV	Reductive pathway likely	2
pH*	5 < pH < 9	Optimal range for reductive pathway	0
	5 > pH > 9	Outside optimal range for reductive pathway	-2
TOC	> 20 mg/L	Carbon and energy source; drives dechlorination; can be natural or anthropogenic	2
Temperature*	> 20°C	At T >20°C biochemical process is accelerated	1
Carbon Dioxide	>2x background	Ultimate oxidative daughter product	1
Alkalinity	>2x background	Results from interaction between CO ₂ and aquifer minerals	1
Chloride*	>2x background	Daughter product of organic chlorine	2
Hydrogen	>1 nM	Reductive pathway possible, VC may accumulate	3
Hydrogen	<1 nM	VC oxidized	0
Volatile Fatty Acids	> 0.1 mg/L	Intermediates resulting from biodegradation of more complex compounds; carbon and energy source	2
BTEX*	> 0.1 mg/L	Carbon and energy source; drives dechlorination	2
Tetrachloroethene		Material released	0
Trichloroethene*		Material released	0
		Daughter product of PCE	2 ^{a/}
DCE*		Material released	0
		Daughter product of TCE	2 ^{a/}
		If cis is > 80% of total DCE it is likely a daughter product	
		1,1-DCE can be chemical reaction product of TCA	
VC*		Material released	0
		Daughter product of DCE	2 ^{a/}
1,1,1-Trichloroethane*		Material released	0
DCA		Daughter product of TCA under reducing conditions	2
Carbon Tetrachloride		Material released	0
Chloroethane*		Daughter product of DCA or VC under reducing conditions	2
Ethene/Ethane	>0.01mg/L	Daughter product of VC/ethene	2
	>0.1 mg/L		3
Chloroform		Material released	0
		Daughter product of Carbon Tetrachloride	2
Dichloromethane		Material released	0
		Daughter product of Chloroform	2

* Required analysis. a/ Points awarded only if it can be shown that the compound is a daughter product (i.e., not a constituent of the source NAPL).

Table 2.4 Interpretation of Points Awarded During Screening Step 1

Score	Interpretation
0 to 5	Inadequate evidence for anaerobic biodegradation* of chlorinated organics
6 to 14	Limited evidence for anaerobic biodegradation* of chlorinated organics
15 to 20	Adequate evidence for anaerobic biodegradation* of chlorinated organics
> 20	Strong evidence for anaerobic biodegradation* of chlorinated organics
<i>*reductive dechlorination</i>	

The following two examples illustrate how Step 1 of the screening process is implemented. The site used in the first example is a former fire training area contaminated with chlorinated solvents mixed with fuel hydrocarbons. The presence of the fuel hydrocarbons appears to reduce the ORP of the ground water to the extent that reductive dechlorination is favorable. The second example contains data from a dry cleaning site contaminated only with chlorinated solvents. This site was contaminated with spent cleaning solvents that were dumped into a shallow dry well situated just above a well-oxygenated, unconfined aquifer with low organic carbon concentrations of dissolved organic carbon.

Example 1: Strong Evidence for Anaerobic Biodegradation (Reductive Dechlorination) of Chlorinated Organics

Analyte	Concentration in Most Contaminated Zone	Points Awarded
Dissolved Oxygen	0.1 mg/L	3
Nitrate	0.3 mg/L	2
Iron (II)	10 mg/L	3
Sulfate	2 mg/L	2
Methane	5 mg/L	3
ORP	-190 mV	2
Chloride	3 times background	2
PCE (released)	1,000 µg/L	0
TCE (none released)	1,200 µg/L	2
cis-DCE (none released)	500 µg/L	2
VC (none released)	50 µg/L	2
Total Points Awarded		23 Points

In this example, the investigator can infer that biodegradation is likely occurring at the time of sampling and may proceed to Step 2.

Example 2: Anaerobic Biodegradation (Reductive Dechlorination) Unlikely

Analyte	Concentration in Most Contaminated Zone	Points Awarded
Dissolved Oxygen	3 mg/L	-3
Nitrate	0.3 mg/L	2
Iron (II)	Not Detected (ND)	0
Sulfate	10 mg/L	2
Methane	ND	0
ORP	+ 100 mV	0
Chloride	background	0
TCE (released)	1,200 µg/L	0
cis-DCE (none released)	ND	0
VC (none released)	ND	0
Total Points Awarded		1 Point

Appendix C
Field Geochemistry Data
Lab Geochemical Analysis

Field Geochemistry Data

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:

386510

Site:

38

Date:

6 May 99

Field Personnel:

Phil Hardy, Barbara Abrecht

Dissolved Oxygen (DO) Measurement

	Time	Reading (mg/L)	Remarks
DO (direct)	1100	0.31	YSI
DO (titration)	1110	0.17	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement

	Time	Reading (mV)	Remarks
Redox Meter #1	1100	⊖ 327.2	Orion
Redox Meter #2	1100	out of range	ORP Tester
Redox Meter #3	1100	⊖ 200	Hanna

Temperature (from GW Quality) =

Hach 210 Spectrophotometer Tests

	Time	Reading (mg/L)	Remarks
Ferrous Iron	1155	0.01	
Total Iron	1140	0.008	
Sulfide	1205	average / 5mls = 0.218	
Sulfate	1227	⊖ 10	under range

Individual Tests

	Time	Reading (mg/L)	Remarks
Chloride	1135	120	
Alkalinity	1220	120	

450-4655

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:
386502

Site:
38

Date:
6 May 99

Field Personnel:
Phil Hardy, Barbara Adcock

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	1115	0.11	YSI
DO (titration)	1130	0.00	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1	1115	⊖ 345.7	Orion
Redox Meter #2	1115	out of Range	ORP Testr
Redox Meter #3	1115	⊖ 256	Hanna

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	1157	0.10	
Total Iron	1147	0.085	
Sulfide	1210	average / Smls = 0.283	
Sulfate	1229	1.0	

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	1140	30+ Drops + sample would not titrate to orange.	
Alkalinity	1225	160	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:

386528

Site:

38

Date:

6 May 99

Field Personnel:

Phil Hardy, Barbara Albrecht

Dissolved Oxygen (DO) Measurement

	Time	Reading (mg/L)	Remarks
DO (direct)	0915	0.47	VSE
DO (titration)	1042	0.22	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement

	Time	Reading (mV)	Remarks
Redox Meter #1	0915	148.4	ORion
Redox Meter #2	0915	80	ORP Tester
Redox Meter #3	0915	45	Hanna

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests

	Time	Reading (mg/L)	Remarks
Ferrous Iron	1036	0.06	
Total Iron	1102	0.050	
Sulfide	1046	0.001	
Sulfate	1052	45	

Individual Tests

	Time	Reading (mg/L)	Remarks
Chloride	1035	70	
Alkalinity	1041	120	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:
38GS19

Site: **Site 38**
Bldg 604

Date: **5/5/99**

Field Personnel: **RS,**
BA,
PH

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	11:30	2.40	VSE
DO (titration)	11:50	1.39	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1		+209.5	avion
Redox Meter #2		+114	Hanna
Redox Meter #3		+5.	Meter not reading accurately

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	1145	0.01	
Total Iron	1205	0.003	Under range
Sulfide	1150	0.001	
Sulfate	1158	25	Cloudy

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	1142	20	
Alkalinity	1155	100	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:

38 GS20

Site:

38

Rldg604

Date:

5/5/99

Field Personnel:

RB,
BA,
PH

Dissolved Oxygen (DO) Measurement

	Time	Reading (mg/L)	Remarks
DO (direct)	1200	0.45	YSI
DO (titration)	1215	0.60	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement

	Time	Reading (mV)	Remarks
Redox Meter #1	1200	⊖ 305	Orian
Redox Meter #2	1205	⊖ 213	Hanna
Redox Meter #3			

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests

	Time	Reading (mg/L)	Remarks
Ferrous Iron	1218	0.12	
Total Iron	1214	0.145	
Sulfide	1226	over range / 0.088	retested w/ 5ml sample
Sulfate	1235	15	

Individual Tests

	Time	Reading (mg/L)	Remarks
Chloride	1210	25	
Alkalinity	1225	80	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
NAS Pensacola
Site 38 - CTO 59

Sample ID:
38-6512

Site:
38

Date:
5 May 99

Field Personnel:
Phil Hardy, Ronnie Britto, Barbara Ashcroft

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	0830	0.49 mg/L	YS2
DO (titration)	0855	0.00	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1	0830	-291.8	YS2 Orion
Redox Meter #2	0835	-217	Hanna
Redox Meter #3	0835	off limits	ORP

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	0845	0.06	
Total Iron		0.039	
Sulfide	0850	over-range / 0.306	1st sample, over range - re-run w/ 5 mls + 20 mls DI
Sulfate	0900	21	

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	0950	75	
Alkalinity	0955	160	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
NAS Pensacola
Site 38 - CTO 59

Sample ID:

38-6803

Site:

38

Date:

5 May 99

Field Personnel:

PH, RB, BA

Dissolved Oxygen (DO) Measurement

	Time	Reading (mg/L)	Remarks
DO (direct)	0850	0.28	YSE
DO (titration)	0900	0.00	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement

	Time	Reading (mV)	Remarks
Redox Meter #1	0850	0262	Orian
Redox Meter #2	0850	0176	Hanner
Redox Meter #3		out of range	ORP

Temperature (from GW Quality) =

Hach 2100 Spectrophotometer Tests

	Time	Reading (mg/L)	Remarks
Ferrous Iron	1010	0.11	
Total Iron	1000	0.111	
Sulfide	1015	0.282	
Sulfate	1020	23	cloudy

Individual Tests

	Time	Reading (mg/L)	Remarks
Chloride	0955	150	
Alkalinity	1000	120	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
NAS Pensacola
Site 38 - CTO 59

Observers R. Joiner, Bk +
P. Hill

Sample ID:
0386-9501-03

Site:
38

Date:
4 May 99

Field Personnel:
Phil Hardy, Barbara Abschelt,
Ronnie Bristo

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	1050 1145	0.87 0.84	YSP
DO (titration)	1150	0.38	W. wheel

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1	1050	⊕ 245 +79	Orion 290A
Redox Meter #2	1100	+ 5.0	ORP Tester
Redox Meter #3	1103	+ 83	Hanna

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	1220	0.00	
Total Iron	1415 1445	0.00 0.000	
Sulfide	1415	0.000	
Sulfate	1430	9	

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	1200	35	
Alkalinity	1205	100	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:
 038G-6506-204

Site:
 38

Date:
 May 4, 1999

Field Personnel:
 Phil Hardy, Ronnie Ritho
 Bob Albrecht

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	1110 ¹¹⁵⁵	0.60 6.9 → 5.6	Y81
DO (titration)	1155	0.78	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1	1110	+74.9 +74.9	Orion 290A
Redox Meter #2		+100	
Redox Meter #3		+83	

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	1400	0.01	
Total Iron	1425 1445	0.01 0.004	
Sulfide	1425	0.1	
Sulfate	1435	22.0	Cloudy

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	1205	40	
Alkalinity		120	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID: 38GS17 Site: ³⁸Bldg 604 Date: 5/5/99 Field Personnel: RB, BA, PH

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	1440	0.36	YSP
DO (titration)	1440	0.32 0.00	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1	1440	-324.8	
Redox Meter #2	1440	out of range	ORP Tester
Redox Meter #3	1440	-218	Hanna

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	1455	0.03	
Total Iron	1535	0.011	
Sulfide	1515	1st Sample over range 2nd Sample over range. 1st = 25 mL 2nd = 5 mL 3rd = 2 mL = 0.443	
Sulfate	1520	16	

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	1455	55	
Alkalinity	1508	220	

* Note H₂S odor present

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
NAS Pensacola
Site 38 - CTO 59

Sample ID: **38G508** Site: **38** Date: **5/5/99** Field Personnel: **RB**
Bldg 604 **BA**
PH

Dissolved Oxygen (DO) Measurement			
	Time	Reading (mg/L)	Remarks
DO (direct)	1530	0.36	YSZ
DO (titration)	1555	0.51	winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement			
	Time	Reading (mV)	Remarks
Redox Meter #1	1530	⊕ 157.3	Orion
Redox Meter #2	1515	-30	OPP Tester
Redox Meter #3	1516	-001	Hanna

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests			
	Time	Reading (mg/L)	Remarks
Ferrous Iron	1557	0.00	
Total Iron	1550	0.010	
Sulfide	1604	0.000	
Sulfate	1610	22	

Individual Tests			
	Time	Reading (mg/L)	Remarks
Chloride	1545	55	
Alkalinity	1600	100	

FIELD DATA RECORDING FORM
NATURAL ATTENUATION FIELD PARAMETER EVALUATION
 NAS Pensacola
 Site 38 - CTO 59

Sample ID:

86532

Site:

38

Date:

6 May 99

Field Personnel:

Phil Hardy, Barbara Annee

Dissolved Oxygen (DO) Measurement

	Time	Reading (mg/L)	Remarks
DO (direct)	1500	0.12	YSI
DO (titration)	1610	0.17	Winkler

pH (from GW Quality) =

Oxidation-Reduction Potential Measurement

	Time	Reading (mV)	Remarks
Redox Meter #1	1500	⊖ 114.5	Orion
Redox Meter #2	1500	⊖ 080	Hanna
Redox Meter #3	1500	Out of Range	ORP Testr

Temperature (from GW Quality) =

Hach 2010 Spectrophotometer Tests

	Time	Reading (mg/L)	Remarks
Ferrous Iron	1602	0.15	
Total Iron		0.510	
Sulfide	1610	0.004	
Sulfate	1618	25	

Individual Tests

	Time	Reading (mg/L)	Remarks
Chloride	1600	60	
Alkalinity	1605	140	

--- ENSAFE ---

ENS1-992650

Sample Names	Carbon Dioxide mg/l	Hydrogen nM	Lab ID	Date Sampled	Date Received	Date Analyzed	Analyst
38GS17-03	60.76	5.60	T20 100	05/05/99	05/10/99	05/17/99	BC
38GS03-03	34.40	2.50	T20 101	05/05/99	05/10/99	05/17/99	BC
38GS19-03	---	0.50	T20 102	05/05/99	05/10/99	05/17/99	BC
38GS20-03	5.86	3.11	T20 103	05/05/99	05/10/99	05/17/99	BC
38GS12-03	23.06	1.94	T20 104	05/05/99	05/10/99	05/17/99	BC
38GS28-03	43.55	0.67	T20 105	05/06/99	05/10/99	05/17/99	BC
38GS02-03	---	1.34	T20 106	05/06/99	05/10/99	05/17/99	BC
38GS06-03	---	0.75	T20 107	05/06/99	05/10/99	05/17/99	BC
38GS32-03	9.52	0.73	T20 108	05/06/99	05/10/99	05/17/99	BC
38GS10-03	---	1.34	T20 109	05/06/99	05/10/99	05/17/99	BC
38GS08-03	---	0.90	T20 110	05/05/99	05/10/99	05/17/99	BC

DETECTION LIMITS	0.60mg/l	0.03nM
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ANALYST



REVIEW



***** QUALITY CONTROL *****

ENS1-992650

— ENSAFE —

CONTINUING CALIBRATION STANDARDS 05/17/99

COMPOUND	FILE ID	TRUE CONC.	MEASURED	% DIFF.
CARBON DIOXIDE	T20 94	7.50	6.84	8.80
HYDROGEN	T20 92	12.25	11.66	4.82

HE IN LOOP 05/17/99

COMPOUND	FILE ID	DET. LIMIT	MEASURED
CARBON DIOXIDE	T20 96	0.60mg/l	ND
HYDROGEN	T20 96	0.03nM	ND

ANALYST INITIALS ABREVIEW slh.

MICROSEEPS, Inc.

220 William Pitt Way, Pittsburgh, PA 15238

Phone: (412) 826-5245

Fax: (412) 826-3433

CHAIN-OF-CUSTODY RECORD

Note: Enter proper letters in Requested Analyses columns below.

Note: If analysis D, E, or K is selected, scratch (option) NOT wanted.

Analysis Options

* A	C1 - C4	G	Chlorinated HC
* B	Hydrogen & Helium	H	BTEX
* C	Permanent Gases (CH ₄ , CO, CO ₂ , N ₂ , O ₂)	J	BTEX & C5 - C10
D	Mercury (Soil) or (Air **)	K	TPH (C5 - C10) or (C4 - C12)
E	TO-14 by GC/MS (Ambient) or (Source **)	L	C11 - C18
F	601 & 602 Compounds	Other	Specify below.

* An additional 22 ml vial of sample is required when requested in combination with another analysis.

** Available upon request.

Company Name:

ENSURE

Address:

Proj. Manager:

Allison Danner-Harris / Ronnie Britto

Proj. Location:

Proj. Number:

Phone #: 901-372-7962

Fax #: 901-372-2454

Sampler's signature:

Barbara Albrecht

Collection		Number of Containers	"Summa" # if Can. used	Sample Type	Sample Identification	Requested Analyses (Other)								Remarks
Date	Time													
5 May 99	1510	1			38GS 17-03	CO ₂	H ₂							
5 May 99	-	1			38GS 03-03	CO ₂	H ₂							
5 May 99	1135	1			38GS 19-03	-	H ₂							
5 May 99	1200	1			38GS 20-03	CO ₂	H ₂							
5 May 99	0920	1			38GS 12-03	CO ₂	H ₂							
6 May 99	0945	1			38GS 28-03	CO ₂	H ₂							
6 May 99	-	1			38GS 02-03	-	H ₂							
6 May 99	1630	1			38GS 06-03	-	H ₂							
6 May 99	1510	1			38GS 032-03	CO ₂	H ₂							
6 May 99	-	1			38GS 10-03	-	H ₂							
5 May 99	-	1			38GS 08-03	-	H ₂							

Results to: Allison Danner-Harris + Ronnie Britto

ENSURE 5724 Summer Trees Drive, Memphis, TN 38134

Invoice to:

Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Barbara Albrecht	ENSURE	7 May 99		[Signature]	Micro Seeps	5-10-99	1000
Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:
Relinquished by:	Company:	Date:	Time:	Received by:	Company:	Date:	Time:

Lab Geochemical Analysis

PENSACOLA, SITE 38
PENSACOLA, SITE 38 NATURAL ATTENUATION

METHANE		SAMPLE ID ----->	038-G-GS01-03	038-G-GS02-03	038-G-GS03-03	038-G-GS06-03	038-G-GS08-03	038-G-GS10-03
		ORIGINAL ID ----->	038GGS0103	038GGS0203	038GGS0303	038GGS0603	038GGS0803	038GGS1003
		LAB SAMPLE ID ---->	S912852*1	S912939*3	S912892*2	S912852*2	S912892*5	S912939*2
		ID FROM REPORT -->	038GGS0103	038GGS0203	038GGS0303	038GGS0603	038GGS0803	038GGS1003
		SAMPLE DATE ----->	05/04/99	05/07/99	05/05/99	05/04/99	05/05/99	05/07/99
		DATE ANALYZED ---->	05/18/99	05/18/99	05/18/99	05/18/99	05/19/99	05/18/99
		MATRIX ----->	Water	Water	Water	Water	Water	Water
		UNITS ----->	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
CAS #	Parameter		NASPD3	NASPD3	NASPD3	NASPD3	NASPD3	NASPD3
74-82-8	METHANE		47. U	360.	330.	47. U	47. U	580.

PENSACOLA, SITE 38
PENSACOLA, SITE 38 NATURAL ATTENUATION

METHANE		SAMPLE ID ----->	038-G-GS12-03	038-G-GS17-03	038-G-GS19-03	038-G-GS20-03	038-G-GS28-03	038-G-GS32-03
		ORIGINAL ID ----->	038GGS1203	038GGS1703	038GGS1903	038GGS2003	038GGS2803	038GGS3203
		LAB SAMPLE ID ---->	S912892*1	S912892*6	S912892*3	S912892*4	S912939*1	S912939*4
		ID FROM REPORT -->	038GGS1203	038GGS1703	038GGS1903	038GGS2003	038GGS2803	038GGS3203
		SAMPLE DATE ----->	05/05/99	05/05/99	05/05/99	05/05/99	05/06/99	05/06/99
		DATE ANALYZED -->	05/18/99	05/19/99	05/18/99	05/19/99	05/18/99	05/18/99
		MATRIX ----->	Water	Water	Water	Water	Water	Water
		UNITS ----->	UG/L	UG/L	UG/L	UG/L	UG/L	UG/L
CAS #	Parameter		NASPO3	NASPO3	NASPO3	NASPO3	NASPO3	NASPO3
74-82-8	METHANE		210.	5300.	47. U	1700.	460.	210.

DATALCP3
07/15/99

PENSACOLA, SITE 38
PENSACOLA, SITE 38 NATURAL ATTENUATION

Page: 3
Time: 14:45

METHANE		SAMPLE ID -----> ORIGINAL ID -----> LAB SAMPLE ID ----> ID FROM REPORT --> SAMPLE DATE -----> DATE ANALYZED ----> MATRIX -----> UNITS ----->	BLK-0-SP03-02 MBLANK1 S9NASP03*1 MBLANK1 05/19/99 Water UG/L	BLK-0-SP03-04 MBLANK2 S9NASP03*4 MBLANK2 05/18/99 Water UG/L				
CAS #	Parameter	NASP03	NASP03					
74-82-8	METHANE	47. U	47. U					

PENSACOLA, SITE 38
PENSACOLA, SITE 38 NATURAL ATTENUATION

SVOA		SAMPLE ID ----->	038-G-GS02-03	038-G-GS10-03	038-G-GS17-03	038-G-GS20-03	BLK-0-SP03-02
		ORIGINAL ID ----->	038GGS0203	038GGS1003	038GGS1703	038GGS2003	MBLANK1
		LAB SAMPLE ID ---->	S912939*6	S912939*5	S912977*1	S912977*2	S9NASP03*1
		ID FROM REPORT -->	038GGS0203	038GGS1003	038GGS1703	038GGS2003	MBLANK1
		SAMPLE DATE ----->	05/07/99	05/07/99	05/07/99	05/07/99	
		DATE ANALYZED -->	05/13/99	05/13/99	05/15/99	05/15/99	05/14/99
		MATRIX ----->	Water	Water	Water	Water	Water
		UNITS ----->	UG/L	UG/L	UG/L	UG/L	UG/L
CAS #	Parameter	NASPO3	NASPO3	NASPO3	NASPO3	NASPO3	
74-87-3	Chloromethane	10. U	10. U	10. U	10. U	10. U	
74-83-9	Bromomethane	10. U	10. U	10. U	10. U	10. U	
75-01-4	Vinyl chloride	10. U	10. U	10. U	15. U	10. U	
75-00-3	Chloroethane	13. U	10. U	10. U	10. U	10. U	
75-35-4	1,1-Dichloroethene	5. U	5. U	5. U	5. U	5. U	
75-09-2	Methylene chloride	5. U	5. U	5. U	5. U	5. U	
75-34-3	1,1-Dichloroethane	5. U	5. U	5. U	5. U	5. U	
67-66-3	Chloroform	5. U	5. U	5. U	5. U	5. U	
71-55-6	1,1,1-Trichloroethane	5. U	5. U	5. U	5. U	5. U	
56-23-5	Carbon tetrachloride	5. U	5. U	5. U	5. U	5. U	
71-43-2	Benzene	5. U	5. U	5. U	5. U	5. U	
107-06-2	1,2-Dichloroethane	5. U	5. U	5. U	5. U	5. U	
79-01-6	Trichloroethene	5. U	5. U	5. U	5. U	5. U	
78-87-5	1,2-Dichloropropane	5. U	5. U	5. U	5. U	5. U	
75-27-4	Bromodichloromethane	5. U	5. U	5. U	5. U	5. U	
108-88-3	Toluene	5. U	5. U	5. U	5. U	5. U	
79-00-5	1,1,2-Trichloroethane	5. U	5. U	5. U	5. U	5. U	
127-18-4	Tetrachloroethene	5. U	5. U	5. U	5. U	5. U	
124-48-1	Dibromochloromethane	5. U	5. U	5. U	5. U	5. U	
108-90-7	Chlorobenzene	5. U	5. U	5. U	5. U	5. U	
100-41-4	Ethylbenzene	14. U	5. U	5. U	5. U	5. U	
100-42-5	Styrene	5. U	5. U	5. U	5. U	5. U	
75-25-2	Bromoform	5. U	5. U	5. U	5. U	5. U	
79-34-5	1,1,2,2-Tetrachloroethane	5. U	5. U	5. U	5. U	5. U	
67-64-1	Acetone	50. U	50. U	50. U	50. U	50. U	
75-15-0	Carbon disulfide	5. U	5. U	5. U	5. U	5. U	
78-93-3	2-Butanone (MEK)	25. U	25. U	25. U	25. U	25. U	
108-10-1	4-Methyl-2-Pentanone (MIBK)	25. U	25. U	25. U	25. U	25. U	
10061-01-5	cis-1,3-Dichloropropene	5. U	5. U	5. U	5. U	5. U	
10061-02-6	trans-1,3-Dichloropropene	5. U	5. U	5. U	5. U	5. U	
591-78-6	2-Hexanone	25. U	25. U	25. U	25. U	25. U	
1330-20-7	Xylene (Total)	5. U	5. U	5. U	5. U	5. U	
540-59-0	1,2-Dichloroethene (total)	5. U	5. U	5. U	5. U	5. U	

PENSACOLA, SITE 38
PENSACOLA, SITE 38 NATURAL ATTENUATION

TOC		SAMPLE ID -----> 038-G-GS02-03 ORIGINAL ID -----> 038GGS0203 LAB SAMPLE ID ----> S912977*4 ID FROM REPORT --> 038GGS0203 SAMPLE DATE -----> 05/07/99 DATE EXTRACTED --> 05/12/99 DATE ANALYZED ----> 05/12/99 MATRIX -----> Water UNITS -----> MG/L	038-G-GS10-03 038GGS1003 S912977*3 038GGS1003 05/07/99 05/12/99 05/12/99 Water MG/L	038-G-GS17-03 038GGS1703 S912977*1 038GGS1703 05/07/99 05/12/99 05/12/99 Water MG/L	038-G-GS20-03 038GGS2003 S912977*2 038GGS2003 05/07/99 05/12/99 05/12/99 Water MG/L	BLK-0-SP03-02 MBLANK1 S9NASP03*1 MBLANK1 05/12/99 05/12/99 Water MG/L	
CAS #	Parameter	NASP03	NASP03	NASP03	NASP03	NASP03	
9999900-01-4	Total Organic Carbon (TOC)	1.6	2.3	29.	3.9	1. U	

Appendix E
CAPZONE Modelling

1.0 INTRODUCTION

1.1 General Conditions

A groundwater model was developed for Site 38, NAS Pensacola to support the feasibility study effort. Contamination attributable to the site is present primarily in the shallow zone of the Sand-and-Gravel Aquifer. Contamination, defined for this model as levels of organics and inorganics exceeding agreed upon Preliminary Remediation Goals, is manifested in two general areas (see Section 7.0 of the RI report). Due to the nature and extent of contamination, primarily by organics, it is likely that some type of active remedial groundwater system will be required at the site.

1.2 Model Objectives

The general objective of the model effort was to assess the feasibility of extracting shallow groundwater to the surface where treatment could be executed. Issues to be addressed included:

- Mass removal and containment of groundwater
- Time frames and discharge rates required for removal of one pore volume of contaminated groundwater covering the two areas of PRG exceedances
- Minimization of gradient reversals near the Pensacola Bay shore such that saltwater intrusion is kept to a minimum.

2.0 CONCEPTUAL MODEL

2.1 Aquifer System Framework

This model was addressed to the surficial zone of the Sand-and-Gravel Aquifer. This unit is approximately 45 feet thick at the site, with 40 saturated feet. Monitored zones in this unit include the "shallow zone" (the upper 20 saturated feet) and the "intermediate zone" (the lower 20 saturated feet). There is 100% hydraulic connection between these zones. The unit as a whole is

unconfined, and terminates at the top of a laterally persistent clay unit (the low permeability zone). See Section 3.0 of the RI for further descriptions of the aquifer system framework.

2.2 Groundwater Flow System

Groundwater flows towards the southeast in a manner consistent with the local topography. The horizontal hydraulic gradient ranges from 0.0006 to 0.0027 for the shallow zone and intermediate zone. Using the geometric mean hydraulic conductivity (K) and a derivation of Darcy's Law, the average pore velocity for groundwater in the shallow zone is 0.47 to 1.58 ft/day, and in the intermediate zone is 0.10 to 0.40 ft/day.

2.3 Hydrologic Boundaries, Sources and Sinks, and Hydraulic Properties

Pensacola Bay lies immediately to the south of the site and is considered an infinite discharge boundary. For the purpose of the model, the upgradient side of the site is considered to be an infinite recharge boundary. The source of groundwater is direct infiltration of precipitation and migration of groundwater from recharge areas upgradient of the site. The geometric mean K of the shallow zone is 241 ft/day, and for the intermediate zone is 59 ft/day. These values were calculated based on the results of 7 specific capacity tests in the shallow zone and 4 in the intermediate zone. See the RI report for additional information concerning hydraulic parameters.

3.0 COMPUTER CODE

3.1 Code Selection

Given the hydrologic simplicity of the site and the model objectives (feasibility and not hard design), an analytical code was selected to model flow at the site. The analytical model CAPZONE was chosen as the preferred code for establishing flow conditions. CAPZONE output is consistent with input for GWPATH, a numerical particle tracking program which was chosen to model advective transport. SURFER was utilized as the pre-and postprocessor for modeling.

3.2 Code Description

CAPZONE is unique for analytical models in that it is capable of importing an infinite number of gradient directions and values (regional piezometric surface) via SURFER input files. In CAPZONE, drawdowns from theoretical pumping wells are calculated on a flat surface; this surface is then superimposed on SURFER-generated site piezometric surface to establish a pumping piezometric surface. This surface is then input into GWPATH, and particle tracking is accomplished through a number of options; typically, reverse pathline analysis is used with success with this model. Output from both CAPZONE and GWPATH is visually presented using SURFER.

4.0 MODEL CONSTRUCTION

4.1 Grid domain

The general site was equidimensionally gridded to comprise the model domain. The domain consisted of 56 nodes in the x direction and 51 nodes in the y direction. Each grid cell dimension was 30 feet by 30 feet.

4.2 Hydraulic Parameters

Several specific capacity tests were conducted on shallow and intermediate zone wells during the RI, and results were presented in the RI report. Transmissivity (T) in the shallow zone is typically orders of magnitude lower than that in the intermediate zone. Given that a) the shallow and intermediate zones are 100% hydraulically connected, and b) using lower T's create larger capture zones than lower Ts, all other parameters being equal, the shallow zone T of 66,356 gallons per day-foot was chosen to input to CAPZONE. This T was arrived at by calculating the geometric mean of the Ts reported from specific capacity testing. Using this higher T over the aquifer thickness of 40 feet will conservatively estimate the size of the resultant capture zone.

For input into GWPATH, vertical and horizontal hydraulic conductivities (K's) were considered to be equal. This is justified based on a) the geologic evidence supporting the homogeneity of the surficial sands, and b) the lack of hydrogeologic evidence supporting a difference between Kh and Kv.

Storativity: a storativity of 0.1 was assigned to the aquifer. This is a generic value based on typical values fro unconfined aquifers.

Porosity: again, a generic value of 30% was assigned to the aquifer based on the geologic evidence of the nature of the surficial deposits.

5.0 PREDICTIVE SIMULATIONS

5.1 Iterations

Numerous iterations were run to achieve adequate areal capture coupled with reasonable recovery times. The scenarios ranged from one well at 95 gpm to 4 wells, each at 30 gpm. These scenarios resulted in various complications, from too much or too little areal coverage, or intrusion of saltwater into the capture zone.

5.2 Preferred Scenario

The resulting preferred scenario consists of two wells, each centered immediately downgradient of each of the two areas of groundwater contamination. Figure 3-13 in the main report illustrates the location of each of the proposed extraction wells and their capture zones. The well extracting the east area pumps at 75 gpm, and the well extracting the west area pumps at 50 gpm. At these rates, one pore volume underlying the east area is captured in one year, and one pore volume under the west area is captured in 180 days.

6.0 SUMMARY AND CONCLUSIONS

6.1 Model Assumptions and Limitations

Use of an analytical model provides inherent assumptions and limitations into the results. A single value for T and K is assigned to the entire model domain; this is clearly an oversimplification of the system. Additionally, as no stressed piezometric surface was ever measured, no residual analysis or calibration of the predicted simulations were conducted. Given that the objective of the modeling was simply to evaluate the feasibility (and not hard design) of groundwater extraction as a remedial alternative, these limitations should not bear great weight against the model results.

6.2 Recommendations

Results of the modeling effort indicate that groundwater extraction as a remedial alternative is viable from a technical standpoint. It is recommended that, from a feasibility/conceptual standpoint, the relative costs of groundwater extraction be based on installation and operation of two extraction wells, pumping at 75 and 50 gpm respectively. It is further recommended that it be considered that one pore volume of groundwater underlying the east area can be captured at 75 gpm in one year, and, under the west area, at 50 gpm in 180 days.

Appendix F
Comparison of Soil Concentrations with SCTLs

F-1:
RI Results

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Aluminum			72000	NA	leach test	leach test	leach test
	038S000102	13,500.00					
	038S000104	181.00					
	038S000106	5,610.00					
	038S000301	121.00					
	038S000303	263.00					
	038S000305	351.00					
	038S000402	339.00					
	038S000404	134.00					
	038S000501	661.00					
	038S000503	86.50					
	038S000505	90.80					
	038S000701	800.00					
	038S000703	741.00					
	038S000705	294.00					
	038S000801	139.00					
	038S000803	353.00					
	038S000804	388.00					
	038S000901	132.00					
	038S000903	97.30					
	038S001001	435.00					
	038S001003	164.00					
	038S001004	51.80					
	038S001101	71.20					
	038S001103	57.50					
	038S001104	114.00					
	038S001201	305.00					
	038S001203	166.00					
	038S001204	132.00					
	038S001301	148.00					
	038S001303	146.00					
	038S001304	78.40					
	038S001401	784.00					
	038S001403	220.00					
	038S001405	88.60					
	038S001501	450.00					
	038S001503	326.00					
	038S001601	9,860.00					
	038S001603	710.00					
	038S001605	137.00 J					
	038S001701	4,220.00					
	038S001703	662.00					
	038S001705	254.00					
	038S001801	4,180.00					
	038S001803	469.00					
	038S001805	1,010.00					
	038S001901	4,580.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Aluminum			72000	NA	leach test	leach test	leach test
	038S001902	3,090.00					
	038S002201	1,000.00					
	038S002203	518.00					
	038S002403	684.00					
	038S002501	104.00					
	038S002503	69.00					
	038S002601	10,300.00					
	038S002603	7,310.00					
	038S002605	2,730.00					
	038S002702	81.00					
	038S002704	77.00					
	038S002801	921.00					
	038S002803	1,090.00					
	038S002901	1,540.00					
	038S003001	214.00 J					
	038S003003	69.70 J					
	038S003101	207.00 J					
	038S003103	160.00 J					
	038S003201	858.00					
	038S003203	185.00					
	038S003205	52.00					
	038S003301	21,200.00 J					
	038S003303	643.00 J					
	038S003401	19,000.00 J					
	038S003403	3,650.00					
	038S003501	12,100.00					
	038S003503	299.00					
	038S003601	24,300.00					
	038S003603	339.00					
	038S003701	16,200.00					
	038S003703	1,980.00					
	038S004102	179.00					
	038S004104	43.40					
	038S004106	24.90					
	038S004202	1,330.00					
	038S004204	1,500.00					
	038S004206	368.00					
Antimony			26	240		5 leach test	50
	038S002201	3.80					
	038S003703	6.10				X	
Arsenic			0.8	3.7		29 leach test	290
	038S000102	1.60	X				
	038S000106	1.20	X				
	038S000301	1.20	X				
	038S000701	2.40	X				
	038S000703	2.20	X				
	038S000705	0.71					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Arsenic			0.8	3.7		29 leach test	290
	038S000901	0.52					
	038S001201	0.81 J					
	038S001203	1.70	X				
	038S001204	15.60	X	X			
	038S001301	0.72					
	038S001303	3.70	X				
	038S001304	3.20	X				
	038S001401	1.90	X				
	038S001403	1.30	X				
	038S001405	0.38					
	038S001501	0.28					
	038S001503	0.66					
	038S001601	2.20	X				
	038S001603	0.60					
	038S001701	1.00	X				
	038S001703	0.32					
	038S001803	1.20	X				
	038S001805	1.10	X				
	038S001901	1.90	X				
	038S001902	0.83	X				
	038S002201	1.60	X				
	038S002601	4.20	X	X			
	038S002603	3.10	X				
	038S002605	7.50	X	X			
	038S002901	1.00	X				
	038S003201	3.00	X				
	038S003205	0.51					
	038S003301	3.90	X	X			
	038S003401	2.40	X				
	038S003403	0.60					
	038S003501	21.10	X	X			
	038S003503	3.50	X				
	038S003601	7.20	X	X			
	038S003603	8.20	X	X			
	038S003701	3.70 J	X				
	038S003703	0.93	X				
	038S004102	1.40	X				
	038S004202	0.91	X				
	038S004204	1.20	X				
Barium			110	87000		1600 leach test	16000
	038S000102	68.70					
	038S000104	2.60					
	038S000106	10.20					
	038S000301	1.20					
	038S000303	2.40					
	038S000305	5.00					
	038S000402	3.20					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Barium			110	87000		1600 leach test	16000
	038S000501	23.80					
	038S000503	3.20					
	038S000505	2.00					
	038S000701	17.20					
	038S000703	14.30					
	038S000705	26.50					
	038S000801	2.00					
	038S000803	5.10					
	038S000804	2.40					
	038S000901	3.90					
	038S000903	1.90					
	038S001001	11.90					
	038S001003	4.60					
	038S001201	6.90					
	038S001203	19.20					
	038S001204	7.70					
	038S001301	2.80					
	038S001303	35.90					
	038S001304	4.50					
	038S001401	19.20					
	038S001403	8.10					
	038S001405	2.80					
	038S001501	6.30					
	038S001503	3.90					
	038S001601	4.70					
	038S001603	9.00					
	038S001605	2.30					
	038S001701	16.90					
	038S001703	2.40					
	038S001705	2.40					
	038S001801	11.70					
	038S001803	10.10					
	038S001805	28.80					
	038S001901	8.30					
	038S001902	13.60					
	038S002201	12.40					
	038S002203	2.80					
	038S002403	6.00					
	038S002501	1.00					
	038S002601	32.70					
	038S002603	21.30					
	038S002605	21.70					
	038S002702	0.62					
	038S002704	1.00					
	038S002801	3.00					
	038S002803	6.00					
	038S002901	18.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Barium			110	87000		1600 leach test	16000
	038S003003	0.58					
	038S003101	1.60					
	038S003103	1.20					
	038S003201	18.00					
	038S003203	5.00					
	038S003205	0.62					
	038S003301	11.70					
	038S003303	1.70					
	038S003401	9.60					
	038S003403	13.60					
	038S003501	89.50					
	038S003503	8.00 J					
	038S003601	13.30 J					
	038S003603	4.50					
	038S004102	2.00					
	038S004104	0.61					
	038S004202	18.90					
	038S004204	16.70					
	038S004206	9.90					
Beryllium			120	800		63 leach test	630
	038S001001	0.27					
	038S001401	0.18					
	038S001601	0.15					
	038S002201	0.14					
	038S003401	0.25					
	038S003501	0.36 J					
Cadmium			75	1300		8 leach test	80
	038S000701	3.40					
	038S000703	1.50					
	038S000803	2.00					
	038S001001	4.00					
	038S001003	1.10					
	038S001104	6.20					
	038S001201	1.80					
	038S001203	1.30					
	038S001301	2.90					
	038S001303	2.00					
	038S001401	18.60					
	038S001403	4.60					
	038S001405	2.10					
	038S001501	1.40					
	038S001503	0.74					
	038S001601	0.60					
	038S001603	4.20					
	038S001605	0.74					
	038S001801	2.10					
	038S001803	0.71					

X

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Cadmium			75	1300		8 leach test	80
	038S002201	0.63					
	038S002803	1.00					
	038S002901	2.00					
	038S003301	1.20					
	038S003603	0.98					
	038S004202	1.40					
Calcium			NOT AVAILABLE				
	038S000102	50,300.00					
	038S000104	233.00					
	038S000106	20,700.00					
	038S000301	477.00					
	038S000303	2,590.00					
	038S000305	3,950.00					
	038S000402	2,970.00					
	038S000404	277.00					
	038S000501	6,120.00					
	038S000503	894.00					
	038S000505	1,300.00					
	038S000701	4,740.00					
	038S000703	2,660.00					
	038S000705	608.00					
	038S000801	1,450.00					
	038S000803	955.00					
	038S000804	4,820.00					
	038S000901	402.00					
	038S000903	113.00					
	038S001001	2,220.00					
	038S001003	752.00					
	038S001004	133.00					
	038S001101	559.00					
	038S001103	392.00					
	038S001104	864.00					
	038S001201	2,990.00					
	038S001203	714.00					
	038S001204	287.00					
	038S001301	712.00					
	038S001303	192.00					
	038S001304	161.00					
	038S001401	972.00					
	038S001403	438.00					
	038S001405	236.00					
	038S001501	6,320.00					
	038S001503	3,440.00					
	038S001601	1,810.00 J					
	038S001603	2,460.00					
	038S001605	282.00					
	038S001701	22,300.00 J					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Calcium			NOT AVAILABLE				
	038S001703	2,480.00 J					
	038S001705	1,380.00 J					
	038S001801	5,190.00 J					
	038S001803	947.00 J					
	038S001805	1,950.00 J					
	038S001901	6,600.00 J					
	038S001902	8,840.00 J					
	038S002201	1,990.00 J					
	038S002203	2,530.00 J					
	038S002403	1,260.00					
	038S002501	454.00					
	038S002503	656.00					
	038S002601	7,340.00					
	038S002603	28,500.00					
	038S002605	2,660.00					
	038S002702	979.00					
	038S002704	229.00					
	038S002801	314.00					
	038S002803	1,990.00					
	038S002901	3,210.00					
	038S003001	1,160.00					
	038S003003	155.00					
	038S003101	1,370.00					
	038S003103	603.00					
	038S003201	2,330.00					
	038S003203	1,660.00					
	038S003205	194.00					
	038S003301	1,370.00					
	038S003303	3,500.00					
	038S003401	4,390.00					
	038S003403	3,140.00					
	038S003501	18,400.00 J					
	038S003503	213.00 J					
	038S003603	239.00 J					
	038S003701	2,380.00 J					
	038S003703	1,930.00 J					
	038S004102	115.00					
	038S004104	63.10					
	038S004106	36.90					
	038S004202	1,440.00					
	038S004204	1,710.00					
	038S004206	347.00					
Chromium			210	420		38 leach test	380
	038S000102	22.10					
	038S000106	7.10					
	038S000301	3.70					
	038S000303	3.90					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Chromium			210	420		38 leach test	380
	038S000305	3.50					
	038S000402	4.70					
	038S000404	2.60					
	038S000501	10.00					
	038S000701	28.60					
	038S000703	12.80					
	038S000705	4.90					
	038S000801	2.40					
	038S000803	6.00					
	038S000804	3.20					
	038S000901	6.90					
	038S000903	2.30					
	038S001001	103.00				X	
	038S001003	31.50					
	038S001004	5.40					
	038S001101	9.40					
	038S001103	10.50					
	038S001104	13.20					
	038S001201	80.20				X	
	038S001203	13.30					
	038S001204	19.40					
	038S001301	713.00	X	X		X	X
	038S001303	553.00	X	X		X	X
	038S001304	296.00	X			X	
	038S001401	665.00	X	X		X	X
	038S001403	331.00	X			X	
	038S001405	155.00				X	
	038S001501	17.50					
	038S001503	12.00					
	038S001601	12.60					
	038S001603	58.80				X	
	038S001605	10.50					
	038S001701	53.40				X	
	038S001703	17.30					
	038S001705	8.80					
	038S001801	291.00	X			X	
	038S001803	48.50				X	
	038S001805	87.80				X	
	038S001901	6.60					
	038S001902	6.30					
	038S002201	10.20					
	038S002203	2.20					
	038S002403	4.00					
	038S002501	7.00					
	038S002503	9.00					
	038S002601	11.50					
	038S002603	8.80					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Chromium			210	420		38 leach test	380
	038S002605	5.20					
	038S002702	6.00					
	038S002704	6.00					
	038S002801	2.00					
	038S002803	32.00					
	038S002901	15.00					
	038S003001	2.10 J					
	038S003003	1.70 J					
	038S003101	4.20 J					
	038S003103	2.90 J					
	038S003201	5.00					
	038S003203	3.00					
	038S003205	11.00					
	038S003301	18.30 J					
	038S003303	1.90 J					
	038S003401	21.10 J					
	038S003403	4.20 J					
	038S003501	11.90					
	038S003601	25.40					
	038S003701	15.00					
	038S003703	3.40					
	038S004202	6.20					
	038S004204	4.00					
Cobalt			4700	110000	leach test	not avalla	leach test
	038S000701	2.60					
	038S000703	5.60					
	038S003001	6.00					
Copper			110	76000	leach test	leach test	leach test
	038S000102	9.20					
	038S000104	13.10					
	038S000106	13.80					
	038S000301	10.60					
	038S000303	8.30					
	038S000305	8.10					
	038S000402	21.70					
	038S000404	21.80					
	038S000501	30.80					
	038S000503	27.60					
	038S000505	8.10					
	038S000701	31.60					
	038S000703	86.00					
	038S000705	38.40					
	038S000801	4.60					
	038S000803	13.40					
	038S000804	3.40					
	038S000901	19.00					
	038S000903	6.40					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Copper			110	76000	leach test	leach test	leach test
	038S001001	13.50					
	038S001003	3.60					
	038S001004	3.40					
	038S001201	13.20					
	038S001203	112.00		X			
	038S001204	29.80					
	038S001301	9.80					
	038S001303	73.20					
	038S001304	60.10					
	038S001401	155.00		X			
	038S001403	390.00		X			
	038S001405	43.00					
	038S001501	9.20					
	038S001503	44.00					
	038S001601	11.80					
	038S001603	12.10					
	038S001605	1.90					
	038S001701	9.60					
	038S001703	5.50					
	038S001705	9.00					
	038S001801	41.20					
	038S001803	33.60					
	038S001805	51.40					
	038S001901	23.20					
	038S001902	31.40					
	038S002201	6.50					
	038S002203	2.40					
	038S002403	4.00					
	038S002501	3.00					
	038S002601	33.40					
	038S002603	177.00		X			
	038S002605	102.00					
	038S002702	19.00					
	038S002704	27.00					
	038S002801	8.00					
	038S002803	20.00					
	038S002901	26.00					
	038S003001	2.20					
	038S003003	7.40					
	038S003101	27.20					
	038S003103	43.80					
	038S003201	131.00		X			
	038S003203	45.00					
	038S003205	8.00					
	038S003301	22.00					
	038S003303	19.20					
	038S003401	6.60					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Copper			110	76000	leach test	leach test	leach test
	038S003403	8.40					
	038S003501	46.40					
	038S003503	7.80					
	038S003601	10.60					
	038S003603	10.20					
	038S003701	9.30					
	038S003703	5.40					
	038S004102	308.00	X				
	038S004104	71.40					
	038S004106	11.40					
	038S004202	14.90					
	038S004204	14.70					
	038S004206	3.70					
Cyanide (CN)			30	39000		40 leach test	400
	038S001101	2.20					
	038S003503	1.00 J					
	038S003603	1.00 J					
	038S003701	1.10 J					
	038S003703	1.10 J					
	038S004104	1.00					
	038S004106	1.10					
	038S004204	1.00					
Iron			23000	480000	leach test	leach test	leach test
	038S000102	4,260.00					
	038S000104	499.00					
	038S000106	3,490.00					
	038S000301	476.00					
	038S000303	433.00					
	038S000305	724.00					
	038S000402	976.00					
	038S000404	1,140.00					
	038S000501	1,950.00					
	038S000503	1,160.00					
	038S000505	466.00					
	038S000701	9,530.00					
	038S000703	14,100.00					
	038S000705	3,600.00					
	038S000801	210.00					
	038S000803	1,730.00					
	038S000804	483.00					
	038S000901	893.00					
	038S000903	322.00					
	038S001001	2,410.00					
	038S001003	721.00					
	038S001004	69.90					
	038S001101	92.40					
	038S001103	77.20					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Iron			23000	480000	leach test	leach test	leach test
	038S001104	153.00					
	038S001201	896.00					
	038S001203	2,340.00					
	038S001204	1,610.00					
	038S001301	442.00					
	038S001303	2,310.00					
	038S001304	453.00					
	038S001401	3,260.00					
	038S001403	5,320.00					
	038S001405	525.00					
	038S001501	551.00					
	038S001503	1,090.00					
	038S001601	7,900.00					
	038S001603	1,590.00 J					
	038S001605	210.00 J					
	038S001701	3,790.00					
	038S001703	922.00					
	038S001705	516.00					
	038S001803	2,690.00					
	038S001805	3,320.00					
	038S001902	2,480.00					
	038S002201	6,290.00					
	038S002203	968.00					
	038S002403	4,280.00					
	038S002501	540.00					
	038S002503	122.00					
	038S002601	6,860.00					
	038S002603	7,330.00					
	038S002605	14,800.00					
	038S002702	312.00					
	038S002704	696.00					
	038S002801	972.00					
	038S002803	1,510.00					
	038S002901	2,820.00					
	038S003001	179.00					
	038S003003	101.00					
	038S003101	510.00					
	038S003103	916.00					
	038S003201	3,710.00					
	038S003203	571.00					
	038S003205	1,150.00					
	038S003301	12,600.00					
	038S003303	444.00					
	038S003401	14,100.00					
	038S003403	2,790.00					
	038S003501	160.00					
	038S003503	513.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Iron			23000	480000	leach test	leach test	leach test
	038S003601	18,800.00					
	038S003603	936.00					
	038S003701	9,800.00					
	038S003703	3,120.00					
	038S004102	471.00					
	038S004104	124.00					
	038S004106	58.00					
	038S004202	1,540.00					
	038S004204	1,560.00					
	038S004206	376.00					
Lead			400	920	leach test	leach test	leach test
	038S000102	64.20					
	038S000104	18.70					
	038S000106	68.30					
	038S000301	20.10					
	038S000303	23.50					
	038S000305	25.30					
	038S000402	151.00					
	038S000404	50.90					
	038S000501	119.00					
	038S000503	125.00					
	038S000505	60.00					
	038S000701	143.00					
	038S000703	425.00					
	038S000705	130.00					
	038S000801	30.10					
	038S000803	135.00					
	038S000804	17.40					
	038S000901	81.00					
	038S000903	31.40					
	038S001001	98.40					
	038S001003	31.80					
	038S001004	5.70					
	038S001101	9.20					
	038S001103	7.70					
	038S001104	24.20					
	038S001201	98.60					
	038S001203	243.00					
	038S001204	126.00					
	038S001301	95.40					
	038S001303	256.00					
	038S001304	110.00					
	038S001401	270.00					
	038S001403	148.00					
	038S001405	45.50					
	038S001501	24.80					
	038S001503	70.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Lead			400	920	leach test	leach test	leach test
	038S001601	40.10					
	038S001603	119.00 J					
	038S001605	23.00					
	038S001701	70.50					
	038S001703	44.50					
	038S001705	34.10					
	038S001801	148.00					
	038S001803	155.00					
	038S001805	491.00	X				
	038S001901	67.00					
	038S001902	60.90					
	038S002201	83.80					
	038S002203	28.90					
	038S002403	6.00					
	038S002501	28.00					
	038S002503	3.00					
	038S002601	119.00					
	038S002603	217.00					
	038S002605	897.00	X				
	038S002702	17.00					
	038S002704	29.00					
	038S002801	23.00					
	038S002803	49.00					
	038S002901	139.00					
	038S003001	28.90 J					
	038S003003	24.10 J					
	038S003101	30.40 J					
	038S003103	46.80 J					
	038S003201	273.00					
	038S003203	63.00					
	038S003205	14.00					
	038S003301	67.10 J					
	038S003303	29.50					
	038S003401	22.00 J					
	038S003403	55.30 J					
	038S003501	125.00					
	038S003503	40.30					
	038S003601	38.30					
	038S003603	23.00					
	038S003701	51.90					
	038S003703	24.70					
	038S004102	5.20					
	038S004104	8.20					
	038S004106	1.40					
	038S004202	70.00					
	038S004204	60.60					
	038S004206	18.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Magnesium			NOT AVAILABLE				
	038S000102	7,210.00					
	038S000104	31.00					
	038S000106	238.00					
	038S000301	60.40					
	038S000505	30.10					
	038S000701	309.00					
	038S000703	717.00					
	038S000705	128.00					
	038S000801	61.60					
	038S000803	68.00					
	038S000804	193.00					
	038S000901	41.50					
	038S001001	140.00					
	038S001003	43.80					
	038S001203	103.00					
	038S001204	51.40					
	038S001301	47.40					
	038S001303	27.90					
	038S001304	18.90					
	038S001401	108.00					
	038S001403	68.10					
	038S001405	23.50					
	038S001501	332.00					
	038S001503	216.00					
	038S001601	107.00					
	038S001603	111.00					
	038S001605	15.90					
	038S001701	288.00					
	038S001703	57.00					
	038S001705	22.90					
	038S001801	218.00					
	038S001803	86.60					
	038S001805	467.00					
	038S001901	223.00					
	038S001902	193.00					
	038S002201	256.00					
	038S002203	84.20					
	038S002403	706.00					
	038S002501	11.00					
	038S002503	13.00					
	038S002601	325.00					
	038S002603	469.00					
	038S002605	413.00					
	038S002702	21.00					
	038S002704	14.00					
	038S002801	87.00					
	038S002803	226.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Magnesium			NOT AVAILABLE				
	038S002901	163.00					
	038S003001	56.30					
	038S003003	19.40					
	038S003101	88.10					
	038S003103	68.10					
	038S003201	427.00					
	038S003203	120.00					
	038S003205	17.00					
	038S003301	213.00					
	038S003303	115.00					
	038S003401	360.00					
	038S003403	185.00					
	038S003501	562.00 J					
	038S003503	89.50 J					
	038S003601	115.00 J					
	038S003603	39.10					
	038S003701	233.00					
	038S003703	186.00					
	038S004102	94.10					
	038S004104	16.20					
	038S004106	7.60					
	038S004202	189.00					
	038S004204	226.00					
	038S004206	41.30					
Manganese			1600	22000	leach test	not availa	leach test
	038S000102	337.00					
	038S000104	13.20					
	038S000106	53.00					
	038S000301	1.30					
	038S000501	11.80					
	038S000505	3.40					
	038S000701	27.60					
	038S000703	36.80					
	038S000705	32.00					
	038S000801	2.50					
	038S000903	3.70					
	038S001203	8.30					
	038S001204	5.00					
	038S001301	1.90					
	038S001303	3.50					
	038S001304	1.40					
	038S001401	11.20					
	038S001403	5.60					
	038S001405	1.90					
	038S001501	4.40					
	038S001503	5.20					
	038S001601	14.50					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Manganese			1600	22000	leach test	not availa	leach test
	038S001603	12.30					
	038S001605	2.50					
	038S001701	34.40					
	038S001703	4.50					
	038S001705	2.50					
	038S001801	11.70					
	038S001803	5.60					
	038S001805	12.70					
	038S001901	28.80					
	038S001902	23.50					
	038S002201	68.50					
	038S002203	10.20					
	038S002403	16.00					
	038S002501	7.00					
	038S002503	1.00					
	038S002601	244.00					
	038S002603	238.00					
	038S002605	138.00					
	038S002702	2.00					
	038S002704	2.00					
	038S002801	12.00					
	038S002803	14.00					
	038S002901	18.00					
	038S003001	2.10 J					
	038S003101	3.50 J					
	038S003103	3.00 J					
	038S003201	27.00					
	038S003203	7.00					
	038S003205	2.00					
	038S003301	30.90 J					
	038S003303	11.50 J					
	038S003401	30.90 J					
	038S003403	31.30 J					
	038S003501	169.00					
	038S003503	8.60					
	038S003601	69.50					
	038S003603	13.90					
	038S003701	174.00					
	038S003703	32.80					
	038S004102	4.00					
	038S004104	3.90					
	038S004106	0.89					
	038S004202	28.50					
	038S004204	37.60					
	038S004206	8.50					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Mercury			3.4	26	2.1	0.01	21
	038S000102	0.04				X	
	038S000104	0.06				X	
	038S000106	0.06				X	
	038S000303	0.04				X	
	038S000305	0.03				X	
	038S000402	0.12				X	
	038S000404	0.08				X	
	038S000501	0.07				X	
	038S000503	0.12				X	
	038S000505	0.05				X	
	038S000701	0.05				X	
	038S000703	0.05				X	
	038S000705	0.04				X	
	038S000803	0.07				X	
	038S000901	0.05				X	
	038S001001	0.10				X	
	038S001003	0.06				X	
	038S001004	0.03				X	
	038S001201	0.12				X	
	038S001203	0.12				X	
	038S001204	0.07				X	
	038S001301	0.05				X	
	038S001303	0.20				X	
	038S001304	0.10				X	
	038S001401	0.07				X	
	038S001403	0.20				X	
	038S001405	0.07				X	
	038S001501	0.03				X	
	038S001503	0.03				X	
	038S001601	0.05				X	
	038S001603	0.07				X	
	038S001605	0.03 J				X	
	038S001701	0.05				X	
	038S001703	0.05				X	
	038S001705	0.15				X	
	038S001801	0.12				X	
	038S001803	0.06				X	
	038S001805	0.12				X	
	038S001901	0.06				X	
	038S001902	0.05				X	
	038S002203	0.03				X	
	038S002601	0.15 J				X	
	038S002603	0.13 J				X	
	038S002605	0.60 J				X	
	038S003003	0.41				X	
	038S003501	0.23				X	
	038S004202	0.10				X	
	038S004204	0.09				X	
	038S004206	0.10				X	

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Nickel			110	28000		130 leach test	1300
	038S000701	2.90 J					
	038S000703	4.20					
	038S001801	6.80					
	038S001803	3.80					
	038S001805	81.50					
	038S002601	4.50					
	038S002603	5.30					
	038S002605	5.90					
Potassium			NOT AVAILABLE				
	038S000102	1,460.00					
	038S001601	110.00					
	038S001603	110.00					
	038S001801	106.00					
	038S001805	115.00					
	038S004106	216.00					
Selenium			390	10000		5 leach test	50
	038S001401	0.21					
Silver			390	9100		17 leach test	170
	038S002605	1.40					
	038S003003	0.83					
	038S004102	1.30					
Sodium			NOT AVAILABLE				
	038S000102	302.00					
	038S000106	204.00					
	038S000402	78.20					
	038S000501	153.00					
	038S000901	23.70					
	038S001001	31.20					
	038S001401	53.20					
	038S001403	29.60					
	038S001501	39.30					
	038S001503	31.30					
	038S001601	43.50					
	038S001603	29.70					
	038S001701	71.50					
	038S001703	23.30					
	038S001803	36.90					
	038S001805	66.50					
	038S001901	84.30					
	038S001902	94.10					
	038S002201	21.60					
	038S002601	85.70					
	038S002603	216.00					
	038S002605	45.40					
	038S002803	45.00					
	038S002901	40.00					
	038S003001	93.40					
	038S003101	57.20					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

INORGANIC COMPOUNDS DETECTED ABOVE CRCLC (mg/L) AND COMPARED TO CRCLC			Direct Exposure		Leachability		
Parameter	Sample ID	Result	Res	Com/Ind	GW Criteria	MSW	Poor Quality
Sodium			NOT AVAILABLE				
	038S003103	50.70					
	038S003301	72.30					
	038S003303	128.00					
	038S003401	84.70					
	038S003403	61.80					
	038S003501	163.00 J					
	038S003503	45.80 J					
	038S003601	40.80 J					
	038S003701	80.00					
	038S003703	51.10					
	038S004102	55.90 B					
	038S004104	41.10					
	038S004106	43.10					
	038S004204	43.10					
Thallium			NOT AVAILABLE				
	038S001204	0.61					
Vanadium			15	7400	980 not availa		9800
	038S000102	16.70	X				
	038S000106	8.70 J					
	038S000701	3.70					
	038S000703	4.40					
	038S000705	6.30					
	038S001001	5.40					
	038S001601	16.60	X				
	038S001603	2.90					
	038S001701	6.90					
	038S001703	1.60					
	038S001801	7.50					
	038S001803	1.50					
	038S001805	6.10					
	038S001901	7.70					
	038S001902	5.00					
	038S002201	14.50					
	038S002403	15.00					
	038S002601	16.30	X				
	038S002603	11.20					
	038S002605	6.70					
	038S002901	4.00					
	038S003201	4.00					
	038S003301	31.70	X				
	038S003401	33.40	X				
	038S003403	6.70					
	038S003501	18.00	X				
	038S003503	1.90					
	038S003601	39.80	X				
	038S003701	26.20	X				
	038S003703	5.00					
	038S004202	2.90					
	038S004204	2.60					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Zinc			23000	560000	6000	not availa	60000
	038S000102	309.00					
	038S000104	13.30					
	038S000106	22.10					
	038S000301	16.90					
	038S000303	18.60					
	038S000305	15.30					
	038S000402	26.40					
	038S000404	29.20					
	038S000501	40.00					
	038S000503	23.80					
	038S000505	13.50					
	038S000701	401.00					
	038S000703	396.00					
	038S000705	89.30					
	038S000801	9.40					
	038S000803	32.80					
	038S000804	5.00					
	038S000901	40.60					
	038S000903	13.40					
	038S001001	74.40					
	038S001003	17.90					
	038S001104	84.90					
	038S001201	56.70					
	038S001203	593.00					
	038S001204	220.00					
	038S001301	54.80					
	038S001303	63.60					
	038S001304	28.90					
	038S001401	435.00					
	038S001403	403.00					
	038S001405	58.90					
	038S001501	32.60					
	038S001503	49.60					
	038S001601	17.90					
	038S001603	55.60					
	038S001605	9.60					
	038S001701	32.00					
	038S001703	7.20					
	038S001705	7.60					
	038S001801	85.20					
	038S001803	38.00					
	038S001805	209.00					
	038S001901	30.80					
	038S001902	31.90					
	038S002201	41.20					
	038S002203	24.00					
	038S002403	7.00					
	038S002501	9.00					
	038S002503	7.00					

RI RESULTS

INORGANIC COMPOUNDS DETECTED ABOVE CRQLS (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		GW Criteria	Leachability	
			Res	Com/Ind		MSW	Poor Quality
Zinc			23000	560000		6000 not availa	60000
	038S002601	126.00					
	038S002603	317.00					
	038S002605	296.00					
	038S002702	7.00					
	038S002704	18.00					
	038S002801	21.00					
	038S002803	36.00					
	038S002901	85.00					
	038S003001	8.50					
	038S003003	3.30					
	038S003101	23.60					
	038S003103	32.80					
	038S003201	88.00					
	038S003203	18.00					
	038S003205	16.00					
	038S003301	48.30					
	038S003303	6.50					
	038S003401	11.00					
	038S003403	37.20					
	038S003501	98.20					
	038S003503	19.20					
	038S003601	215.00					
	038S003603	8.40					
	038S003701	35.70					
	038S003703	19.50					
	038S004102	126.00					
	038S004104	10.00					
	038S004106	4.60					
	038S004202	50.40					
	038S004204	41.40					
	038S004206	20.20					

RI RESULTS

PESTICIDE COMPOUNDS DETECTED ABOVE CRQLS (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
4,4'-DDD			4600	18000	4000	100	40000
	038S001301	6.30 J					
	038S001603	5.60 J					
	038S001703	4.80					
	038S001705	5.30					
	038S001801	77.00					
	038S001803	59.00					
	038S001805	43.00 J					
	038S003403	5.00 J					
4,4'-DDE			3300	13000	18000	100	180000
	038S001301	5.80					
	038S001603	4.10 J					
	038S001701	3.90 J					
	038S001703	4.10					
	038S001705	3.90					
	038S001801	900.00 J					X
	038S001803	660.00					X
	038S001805	480.00					X
	038S003701	4.90					
	038S004204	5.10					
4,4'-DDT			3300	1300	11000	60	110000
	038S001603	4.50 J					
	038S001701	3.50 J					
	038S001705	5.50					
	038S002603	5.70 J					
	038S003403	6.30 J					
	038S004204	5.10					
alpha-Chlordane			3100	12000	9600	3	96000
	038S001301	2.60					
Aroclor-1254			500	2100	17000	2	170000
	038S001701	100.00					X
	038S001703	86.00 J					X
	038S001705	72.00 J					X
	038S001801	16000.00 J	X	X			X
	038S001803	11000.00 J	X	X			X
	038S001805	8000.00 J	X	X			X
Aroclor-1260			500	2100	17000	2	170000
	038S001201	58.00					X
	038S001301	55.00					X
	038S001603	120.00 J					X
	038S003403	49.00 J					X
	038S003701	570.00 J	X				X
Dieldrin			70	300	4	0.1	40
	038S002603	4.40 J			X		X
	038S003701	5.40			X		X

RI RESULTS

PESTICIDE COMPOUNDS DETECTED ABOVE CRQLS (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Endosulfan I			410000	6700000	3800	0.8	38000
	038S001801	51.00 J				X	
	038S001803	61.00 J				X	
	038S001805	34.00 J				X	
Endosulfan USE ENDOSULFAN I			410000	6700000	3800	0.8	38000
	038S001603	5.80 J				X	
	038S001703	4.50 J				X	
	038S001705	4.60 J				X	
	038S001805	18.00 J				X	
Endosulfan USE ENDOSULFAN I			410000	6700000	3800	0.8	38000
	038S003303	3.40				X	
Endrin alde USE ENDRIN			21000	340000	1000	1	10000
	038S001801	37.00 J				X	
	038S003701	29.00 J				X	
Endrin keto USE ENDRIN			21000	340000	1000	1	10000
	038S003403	14.00 J				X	
gamma-Chlordane TOTAL!!!			3100	12000	9600	3	96000
	038S001603	1.80 J					
	038S001701	3.40 J				X	
	038S001703	2.30 J					
	038S001705	2.10 J					
	038S001801	630.00 J				X	
	038S001803	410.00 J				X	
	038S001805	270.00 J				X	
Heptachlor epoxide			100	400	600	6	6000
	038S001703	1.70 J					
Methoxychlor			370000	7500000	160000	100	1600000
	038S003403	25.00 J					

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
1,2,4-Trichlorobenzene			560000	7500000	5300	1700	5300
	038S001301	48.00 J					
	038S001401	88.00 J					
1,2-Dichlorobenzene			650000	4600000	17000	2800	170000
	038S001301	510.00					
	038S001303	280.00 J					
	038S001304	61.00 J					
	038S001401	610.00					
	038S001403	350.00 J					
	038S001405	80.00 J					
1,4-Dichlorobenzene			6000	9000	2200	2900	22000
	038S001301	53.00 J					
	038S001401	100.00 J					
	038S001403	65.00 J					
2,4-Dimethylphenol			910000	9800000	1700	3200	17000
	038S001001	160.00 J					
	038S001401	380.00					
	038S001403	210.00 J					
	038S001405	220.00 J					
2-Methylnaphthalene			80000	560000	6100	9100	61000
	038S001001	100.00 J					
	038S001401	53.00 J					
	038S001701	270.00 J					
	038S001705	88.00 J					
	038S003003	37.00 J					
	038S003205	1,400.00					
2-Methylphenol (o-Cresol)			2400000	2.8E+07	300	3300	3000
	038S001301	42.00 J					
	038S001401	340.00 J			X		
	038S001403	250.00 J					
	038S001405	66.00 J					
4-Methylphenol (p-Cresol)			250000	3000000	30	500	300
	038S001401	740.00			X	X	X
	038S001403	580.00			X	X	X
	038S001405	190.00 J			X		
Acenaphthylene			100000	1.1E+07	27000	700	270000
	038S000102	85.00 J					
	038S000106	87.00 J					
	038S000803	48.00 J					
	038S001203	62.00 J					
	038S002601	89.00 J					
	038S002603	230.00 J					
	038S002605	71.00 J					
	038S003003	49.00 J					
	038S003201	89.00 J					
	038S003303	39.00 J					
	038S003401	92.00 J					

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Anthracene			1.8E+07	2.6E+08	2500000	700	25000000
	038S000803	43.00 J					
	038S001203	47.00 J					
	038S002601	100.00 J					
	038S002603	180.00 J					
	038S003201	160.00 J					
	038S003205	120.00 J					
Benzo(a)anthracene			1400	5000	3200	700	32000
	038S000102	190.00 J					
	038S000104	43.00 J					
	038S000106	440.00 J					
	038S000701	61.00 J					
	038S000703	37.00 J					
	038S000803	250.00 J					
	038S001001	70.00 J					
	038S001203	440.00					
	038S001204	42.00 J					
	038S001401	100.00 J					
	038S001403	64.00 J					
	038S001603	190.00 J					
	038S001901	78.00 J					
	038S002601	140.00 J					
	038S002603	260.00 J					
	038S002605	220.00 J					
	038S002901	120.00 J					
	038S003201	480.00 J					
	038S003303	37.00 J					
	038S003401	110.00 J					
	038S003501	230.00 J					
Benzo(a)pyrene			100	500	8000	1200	80000
	038S000102	200.00 J	X				
	038S000104	40.00 J					
	038S000106	440.00 J	X				
	038S000701	46.00 J					
	038S000803	230.00 J	X				
	038S001203	410.00	X				
	038S001204	59.00 J					
	038S001401	67.00 J					
	038S001901	77.00 J					
	038S002601	160.00 J	X				
	038S002603	300.00 J	X				
	038S002605	260.00 J	X				
	038S002901	200.00 J	X				
	038S003201	690.00 J	X	X			
	038S003301	41.00 J					
	038S003303	60.00 J					
	038S003401	150.00 J	X				
	038S003501	380.00 J	X				
	038S003701	260.00 J	X				
	038S004204	190.00 J	X				

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

			Direct Exposure		Leachability							
Parameter	Sample ID	Result	Res	Com/Ind	GW Criteri	MSW	Poor Quality					
Benzo(b)fluoranthene			1400	4800	10000	1600	100000					
	038S000102	280.00 J	X									
	038S000104	43.00 J										
	038S000106	530.00 J										
	038S000701	62.00 J										
	038S000801	43.00 J										
	038S000803	200.00 J										
	038S001001	56.00 J										
	038S001203	560.00										
	038S001204	65.00 J										
	038S001401	200.00 J										
	038S001403	150.00 J										
	038S001405	84.00 J										
	038S001603	230.00 J										
	038S001901	200.00 J										
	038S002901	370.00 J										
	038S003003	51.00 J										
	038S003101	48.00 J										
	038S003201	580.00 J										
	038S003203	120.00 J										
	038S003301	45.00 J										
	038S003303	75.00 J										
	038S003401	160.00 J										
	038S003403	2,100.00 J										
	038S003701	500.00 J										
	038S003703	73.00 J										
	038S004202	55.00 J										
	038S004204	380.00 J										
	038S004206	48.00 J										
Benzo(g,h,i)perylene			2300000	4.1E+07	32000000	4800	320000000					
	038S000102	130.00 J										
	038S000106	360.00 J										
	038S001203	340.00 J										
	038S001204	52.00 J										
	038S002601	140.00 J										
	038S002603	120.00 J										
	038S002605	240.00 J										
	038S002901	300.00 J										
	038S003003	66.00 J										
	038S003101	35.00 J										
	038S003201	530.00 J										
	038S003301	39.00 J										
	038S003303	56.00 J										
	038S003401	120.00 J										
	038S003501	290.00 J										
	038S003701	360.00 J										
	038S004204	210.00 J										
Benzo(k)fluoranthene								15000	52000	25000	1600	250000
	038S000102	220.00 J										
	038S000104	51.00 J										
	038S000106	410.00 J										
	038S000701	51.00 J										

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Benzo(k)fluoranthene			15000	52000	25000	1600	250000
	038S000703	40.00 J					
	038S000801	53.00 J					
	038S000803	300.00 J					
	038S001001	38.00 J					
	038S001203	490.00					
	038S001204	71.00 J					
	038S001401	70.00 J					
	038S001403	65.00 J					
	038S001603	190.00 J					
	038S001901	92.00 J					
	038S002601	190.00 J					
	038S002603	330.00 J					
	038S002605	270.00 J					
	038S002702	110.00 J					
	038S002901	290.00 J					
	038S003201	720.00 J					
	038S003203	96.00 J					
	038S003403	910.00 J					
	038S003501	480.00 J					
	038S003701	360.00 J					
bis(2-Ethylhexyl)phthalate (BEHP)			7600	280000	3600000	12000	3600000
	038S000102	360.00 J					
	038S000301	74.00 J					
	038S000303	300.00 J					
	038S000305	240.00 J					
Carbazole			53000	190000	600	6500	6000
	038S002601	38.00 J					
Chrysene			140000	450000	77000	700	770000
	038S000102	220.00 J					
	038S000104	52.00 J					
	038S000106	540.00 J					
	038S000701	71.00 J					
	038S000703	50.00 J					
	038S000801	35.00 J					
	038S000803	280.00 J					
	038S001001	85.00 J					
	038S001203	560.00					
	038S001204	65.00 J					
	038S001401	140.00 J					
	038S001403	93.00 J					
	038S001405	44.00 J					
	038S001603	240.00 J					
	038S001901	120.00 J					
	038S002201	73.00 J					
	038S002601	160.00 J					
	038S002603	280.00 J					
	038S002605	280.00 J					
	038S002702	70.00 J					
	038S002901	110.00 J					
	038S003201	540.00 J					
	038S003203	77.00 J					

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Chrysene			140000	450000	77000	700	770000
	038S003303	42.00 J					
	038S003401	120.00 J					
	038S003403	1,800.00				X	
	038S003501	420.00 J					
	038S003701	240.00 J					
Dibenz(a,h)anthracene			100	500	30000	4700	300000
	038S000102	100.00 J					
	038S000106	140.00 J	X				
	038S000803	69.00 J					
	038S001203	160.00 J	X				
	038S001401	57.00 J					
	038S001403	42.00 J					
	038S002901	180.00 J	X				
	038S003201	230.00 J	X				
	038S003403	590.00 J	X	X			
Dibenzofuran			280000	5000000	15000	36000	150000
	038S001001	140.00 J					
Fluoranthene			2900000	4.8E+07	1200000	1300	12000000
	038S000102	240.00 J					
	038S000104	59.00 J					
	038S000106	560.00 J					
	038S000701	60.00 J					
	038S000703	45.00 J					
	038S000801	38.00 J					
	038S000803	350.00 J					
	038S000804	37.00 J					
	038S001001	52.00 J					
	038S001203	940.00					
	038S001204	91.00 J					
	038S001401	140.00 J					
	038S001403	89.00 J					
	038S001901	74.00 J					
	038S002601	170.00 J					
	038S002603	310.00 J					
	038S002605	470.00					
	038S002702	140.00 J					
	038S002901	97.00 J					
	038S003201	620.00 J					
	038S003203	120.00 J					
	038S003205	180.00 J					
	038S003401	160.00 J					
	038S003403	3,200.00				X	
	038S003501	280.00 J					
	038S003701	280.00 J					
Indeno(1,2,3-cd)pyrene			1500	5300	28000	4300	280000
	038S000102	190.00 J					
	038S000106	300.00 J					
	038S000803	140.00 J					
	038S001203	430.00					
	038S001204	54.00 J					

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Indeno(1,2,3-cd)pyrene			1500	5300	28000	4300	280000
	038S001403	82.00 J					
	038S001805	180.00 J					
	038S002601	130.00 J					
	038S002603	220.00 J					
	038S002605	200.00 J					
	038S002901	190.00 J					
	038S003201	570.00 J					
	038S003301	38.00 J					
	038S003303	53.00 J					
	038S003403	1,400.00					
	038S003501	290.00 J					
	038S003701	210.00 J					
	038S004204	240.00 J					
Naphthalene			40000	270000	1700	2200	17000
	038S001001	46.00 J					
	038S001401	330.00 J					
	038S001403	190.00 J					
	038S001405	150.00 J					
	038S001701	640.00 J					
	038S001703	110.00 J					
	038S001705	100.00 J					
	038S003003	38.00 J					
	038S003205	530.00 J					
Phenanthrene			2000000	3E+07	250000	700	2500000
	038S000106	110.00 J					
	038S000701	55.00 J					
	038S000703	58.00 J					
	038S000803	180.00 J					
	038S001001	260.00 J					
	038S001003	39.00 J					
	038S001203	320.00 J					
	038S001204	45.00 J					
	038S001401	190.00 J					
	038S001403	140.00 J					
	038S001701	86.00 J					
	038S001705	190.00 J					
	038S002601	49.00 J					
	038S002605	110.00 J					
	038S003201	270.00 J					
	038S003205	110.00 J					
Phenol			900	3.9E+08	50	30	500
	038S001201	39.00 J				X	
	038S001301	59.00 J			X	X	
	038S001303	46.00 J				X	
	038S001401	990.00	X		X	X	X
	038S001403	830.00			X	X	X
	038S001405	180.00 J			X	X	
	038S001501	130.00 J			X	X	
	038S001503	110.00 J			X	X	
	038S001801	930.00 J	X		X	X	X
	038S001805	360.00 J			X	X	
	038S001901	370.00 J			X	X	
	038S001902	600.00 J			X	X	X

RI RESULTS

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Pyrene			2200000	3.7E+07	880000	1300	8800000
	038S000102	240.00 J					
	038S000104	59.00 J					
	038S000106	570.00 J					
	038S000701	87.00 J					
	038S000703	62.00 J					
	038S000801	43.00 J					
	038S000803	410.00					
	038S000804	43.00 J					
	038S001001	84.00 J					
	038S001203	750.00					
	038S001204	73.00 J					
	038S001401	150.00 J					
	038S001403	93.00 J					
	038S001405	39.00 J					
	038S001603	200.00 J					
	038S001901	100.00 J					
	038S002601	210.00 J					
	038S002603	360.00 J					
	038S002605	460.00					
	038S002702	110.00 J					
	038S002901	120.00 J					
	038S003201	480.00 J					
	038S003203	89.00 J					
	038S003205	110.00 J					
	038S003301	40.00 J					
	038S003303	45.00 J					
	038S003401	170.00 J					
	038S003403	2,900.00					X
	038S003501	270.00 J					
	038S003701	190.00 J					

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
1,1,1-Trichloroethane			400000	3300000	1900	2600	19000
	038S000701	21.00					
	038S000703	5.00 J					
	038S000705	18.00					
	038S000803	8.00 J					
	038S000804	7.00 J					
	038S000901	17.00					
	038S000903	3.00 J					
	038S001001	240.00					
	038S001003	23.00 D					
	038S001004	3.00 J					
	038S001201	1.00 J					
	038S001203	1.00 J					
	038S001204	3.00 J					
	038S001301	5.00 J					
	038S001303	12.00					
	038S001304	9.00 J					
	038S001401	64.00					
	038S001403	150.00					
	038S001405	5.00 J					
	038S001501	5.00 J					
	038S001503	3.00 J					
	038S001603	5.00 J					
	038S001701	4.00 J					
	038S001705	2.00 J					
	038S001801	5.00 J					
	038S001803	2.00 J					
	038S001805	91.00					
	038S001901	5.00 J					
	038S001902	4.00 J					
	038S002801	2.00 J					
	038S002803	17.00					
	038S004204	1.00 J					
1,1,2,2-Tetrachloroethane			700	1100	2	80	20
	038S000703	1.00 J					
1,1-Dichloroethane			290000	2000000	400 not avail		4000
	038S000701	12.00					
	038S000703	3.00 J					
	038S000705	6.00 J					
	038S000901	4.00 J					
	038S001001	11.00 J					
	038S001204	1.00 J					
	038S001303	4.00 J					
	038S001401	6.00 J					
	038S001403	15.00					
	038S001805	3.00 J					
	038S002803	5.00 J					

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
1,2-Dichloroethane			500	700	10	20	100
	038S000501	5.00 J					
	038S001303	2.00 J					
	038S001401	27.00 J			X	X	
	038S001403	22.00			X	X	
1,2-Dichloroethene (total)		CIS- ISOME	19000	130000	400	not avail	4000
	038S000701	56.00					
	038S000703	30.00					
	038S000705	26.00					
	038S000803	5.00 J					
	038S000804	1.00 J					
	038S000901	21.00					
	038S000903	3.00 J					
	038S001203	2.00 J					
	038S001301	1.00 J					
	038S001303	9.00 J					
	038S001304	1.00 J					
	038S001805	2.00 J					
	038S002803	5.00 J					
2-Butanone (MEK)			3100000	21000000	17000	490000	170000
	038S000402	4.00 J					
	038S000404	8.00 J					
	038S000503	3.00 J					
	038S001003	5.00 DJ					
	038S001004	6.00 J					
	038S001101	5.00 J					
	038S001104	7.00 J					
	038S001401	22.00 J					
	038S001403	15.00					
	038S001405	17.00 J					
	038S001501	6.00 J					
	038S001601	3.00 J					
	038S001603	6.00 J					
	038S001805	8.00 J					
	038S001901	7.00 J					
	038S001902	10.00 J					
	038S002201	5.00 J					
	038S002203	3.00 J					
	038S002403	1.00 J					
	038S002704	1.00 J					
	038S002803	2.00 J					
4-Methyl-2-Pentanone (MIBK)			220000	1500000	2600	110000	26000
	038S003201	38.00					

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Acetone			780000	5500000	2800	6800	28000
	038S000903	19.00					
	038S001001	91.00					
	038S001003	150.00 D					
	038S001004	54.00					
	038S001101	41.00					
	038S001103	84.00					
	038S001104	120.00					
	038S001401	76.00					
	038S001403	140.00					
	038S001405	89.00 D					
	038S001501	54.00					
	038S001503	19.00					
	038S001603	160.00 J					
Benzene			1100	1600	7	500	70
	038S000501	3.00 J					
	038S003201	2.00 J					
	038S003203	2.00 J					
Carbon disulfide			200000	1400000	5600	800	56000
	038S000703	2.00 J					
Carbon tetrachloride			400	600	40	60	400
	038S000102	2.00 J					
	038S000102	2.00 J					
	038S000102	2.00 J					
	038S000501	2.00 J					
	038S000703	2.00 J					
	038S001104	1.00 J					
	038S001301	3.00 J					
	038S001303	1.00 J					
	038S001403	1.00 J					
	038S001703	1.00 J					
	038S001801	1.00 J					
	038S001805	3.00 J					
	038S002201	1.00 J					
Chlorobenzene			30000	200000	1300	200	13000
	038S001301	1.00 J					
	038S001303	11.00					
	038S001304	4.00 J					
	038S001403	2.00 J					
Chloroform			400	500	30	2800	300
	038S000701	3.00 J					
	038S000803	3.00 J					
	038S000804	1.00 J					
	038S000901	5.00 J					
	038S000903	1.00 J					
	038S001301	2.00 J					

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Chloroform			400	500	30	2800	300
	038S001303	8.00 J					
	038S001304	2.00 J					
	038S001401	47.00 J			X		
	038S001403	79.00			X		
	038S001501	1.00 J					
	038S001805	3.00 J					
Ethylbenzene			1100000	8400000	600	12000	6000
	038S000102	1.00 J					
	038S000102	1.00 J					
	038S000102	1.00 J					
	038S000501	4.00 J					
	038S001303	2.00 J					
	038S001603	1.00 J					
	038S001701	1.00 J					
	038S001703	1.00 J					
	038S001801	1.00 J					
	038S001805	2.00 J					
	038S002201	3.00 J					
	038S002501	1.00 J					
	038S002503	1.00 J					
	038S002901	2.00 J					
	038S003201	2.00 J					
	038S003203	3.00 J					
Methylene chloride			16000	23000	20	7300	200
	038S001603	19.00 J					
	038S001801	9.00 J					
Tetrachloroethene			8900	17000	30	100	300
	038S000501	2.00 J					
	038S000701	17.00					
	038S000703	16.00					
	038S000705	26.00					
	038S000803	11.00 J					
	038S000804	4.00 J					
	038S000901	13.00					
	038S000903	2.00 J					
	038S001001	94.00			X		
	038S001003	27.00					
	038S001004	1.00 J					
	038S001103	1.00 J					
	038S001104	11.00					
	038S001204	3.00 J					
	038S001301	43.00			X		
	038S001303	23.00					
	038S001304	17.00					
	038S001401	370.00			X	X	X

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Tetrachloroethene			8900	17000	30	100	300
	038S001403	410.00 J			X	X	X
	038S001405	120.00			X	X	
	038S001501	8.00 J					
	038S001503	1.00 J					
	038S001603	2.00 J					
	038S001701	2.00 J					
	038S001703	2.00 J					
	038S001705	15.00					
	038S001801	15.00					
	038S001803	3.00 J					
	038S001805	230.00			X	X	
	038S001901	7.00 J					
	038S001902	5.00 J					
	038S002201	1.00 J					
	038S003201	4.00 J					
	038S004202	6.00 J					
	038S004204	15.00					
	038S004206	4.00 J					
Toluene			380000	2600000	500	5600	5000
	038S000102	10.00 J					
	038S000102	10.00 J					
	038S000102	10.00 J					
	038S000104	6.00 J					
	038S000402	2.00 J					
	038S000404	4.00 J					
	038S000501	27.00					
	038S000503	23.00					
	038S000505	22.00					
	038S000701	13.00					
	038S000703	34.00					
	038S000705	34.00					
	038S000801	2.00 J					
	038S000803	78.00					
	038S000804	24.00					
	038S000901	140.00					
	038S000903	14.00					
	038S001001	8.00 J					
	038S001003	7.00 J					
	038S001004	13.00					
	038S001104	4.00 J					
	038S001201	29.00					
	038S001203	20.00					
	038S001204	32.00					
	038S001301	110.00					
	038S001303	97.00					
	038S001304	61.00					

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Toluene			380000	2600000	500	5600	5000
	038S001401	29.00 J					
	038S001403	33.00					
	038S001405	6.00 J					
	038S001501	8.00 J					
	038S001503	9.00 J					
	038S001601	4.00 J					
	038S001603	22.00					
	038S001701	16.00 J					
	038S001703	11.00 J					
	038S001705	18.00 J					
	038S001801	15.00 J					
	038S001803	9.00 J					
	038S001805	60.00					
	038S002201	80.00					
	038S002503	4.00 J					
	038S002601	6.00 J					
	038S002603	6.00 J					
	038S002605	25.00					
	038S002704	2.00 J					
	038S002801	4.00 J					
	038S002803	8.00 J					
	038S002901	10.00 J					
	038S003201	21.00					
	038S003301	2.00 J					
	038S003501	8.00 J					
	038S003701	2.00 J					
	038S003703	2.00 J					
	038S004202	21.00					
	038S004204	42.00					
	038S004206	5.00 J					
Trichloroethene			6000	8500	30	900	300
	038S000301	2.00 J					
	038S000303	2.00 J					
	038S000305	3.00 J					
	038S000701	110.00			X		
	038S000703	79.00			X		
	038S000705	74.00			X		
	038S000803	33.00			X		
	038S000804	12.00					
	038S000901	36.00			X		
	038S000903	4.00 J					
	038S001001	23.00 J					
	038S001003	7.00 J					
	038S001201	17.00					
	038S001203	10.00 J					
	038S001204	21.00					

RI RESULTS

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Trichloroethene			6000	8500	30	900	300
	038S001301	34.00			X		
	038S001303	120.00			X		
	038S001304	34.00			X		
	038S001401	390.00			X		X
	038S001403	400.00 J			X		X
	038S001405	13.00 J					
	038S001501	14.00					
	038S001503	17.00					
	038S001603	2.00 J					
	038S001705	2.00 J					
	038S001801	4.00 J					
	038S001803	2.00 J					
	038S001805	110.00			X		
	038S001901	10.00 J					
	038S001902	6.00 J					
	038S002201	2.00 J					
	038S002704	1.00 J					
	038S002803	10.00 J					
	038S002901	1.00 J					
	038S004202	9.00 J					
	038S004204	21.00					
	038S004206	6.00 J					
Xylene (Total)			5900000	40000000	200	3900	2000
	038S001603	14.00 J					
	038S001801	16.00 J					
	038S001805	11.00 J					
	038S001901	8.00					
	038S002501	3.00 J					
	038S002503	3.00 J					
	038S002605	1.00 J					
	038S002801	1.00 J					
	038S002803	2.00 J					
	038S002901	4.00 J					
	038S003201	7.00 J					
	038S004204	2.00 J					

F-2:
USEPA Results

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T4002	4.10					
	038S0T4101	29.00					
	038S0T4102	2.00					
	038S0T4201	24.00					
Cadmium			75	1300		8 leach tes	80
	038S0I1001	2.40					
	038S0I1002	2.20					
	038S0S2301	1.20					
	038S0T0301	0.72					
	038S0T0401	0.54					
	038S0T0701	1.20					
	038S0T0802	1.70					
	038S0T0901	1.30					
	038S0T1001	0.50					
	038S0T1002	0.94					
	038S0T1101	0.92					
	038S0T1301	1.30					
	038S0T1601	1.50					
	038S0T1701	1.40					
	038S0T2301	1.30					
	038S0T3101	2.00					
	038S0T3401	0.56					
	038S0T3501	1.10					
	038S0T3601	2.00					
	038S0T3801	4.60					
	038S0T3901	2.50					
	038S0T4001	2.40					
	038S0T4002	1.20					
	038S0T4101	17.00				X	
	038S0T4102	3.40					
	038S0T4201	21.00				X	
Calcium			NOT AVAILABLE				
	038S0S2301	330.00					
	038S0S2302	350.00					
	038S0T0101	4,400.00					
	038S0T0201	940.00					
	038S0T0301	2,800.00					
	038S0T0302	1,500.00					
	038S0T0401	1,200.00					
	038S0T0502	54.00					
	038S0T0601	3,600.00					
	038S0T0602	83.00					
Calcium			NOT AVAILABLE				
	038S0T0701	4,100.00					
	038S0T0801	260.00					
	038S0T0802	210.00					
	038S0T0901	290.00					
	038S0T1001	510.00					
	038S0T1002	270.00					
	038S0T1101	4,100.00 A					
	038S0T1102	150.00					
	038S0T1201	660.00					
	038S0T1202	260.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T1301	22,000.00					
	038S0T1302	1,600.00					
	038S0T1401	360.00					
	038S0T1501	720.00					
	038S0T1502	160.00					
	038S0T1601	9,700.00					
	038S0T1701	7,900.00					
	038S0T1702	260.00					
	038S0T1801	2,000.00					
	038S0T1802	1,800.00					
	038S0T1902	5,400.00					
	038S0T2001	5,800.00 A					
	038S0T2201	170.00					
	038S0T2202	240.00					
	038S0T2301	3,500.00					
	038S0T2501	2,000.00					
	038S0T2502	64.00					
	038S0T2601	1,400.00					
	038S0T2701	1,100.00					
	038S0T2801	170.00					
	038S0T2802	150.00					
	038S0T2901	190.00					
	038S0T2902	2,900.00					
	038S0T3002	57.00					
	038S0T3101	380.00					
	038S0T3201	55.00					
	038S0T3202	200.00					
	038S0T3301	430.00					
	038S0T3302	68.00					
	038S0T3401	730.00					
	038S0T3501	2,000.00					
	038S0T3502	150.00					
	038S0T3601	1,900.00					
	038S0T3701	480.00					
	038S0T3801	620.00					
	038S0T3901	1,200.00					
	038S0T4001	1,100.00					
Calcium			NOT AVAILABLE				
	038S0T4002	510.00					
	038S0T4101	1,900.00					
	038S0T4102	110.00					
	038S0T4201	1,900.00					
Chromium			210	420	38 leach tes		380
	038S0I1001	93.00			X		
	038S0I1002	20.00					
	038S0S2301	3.00					
	038S0S2302	1.70					
	038S0T0101	17.00					
	038S0T0201	5.90					
	038S0T0301	11.00					
	038S0T0302	4.40					
	038S0T0401	8.70					
	038S0T0502	3.80					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T0601	4.80					
	038S0T0701	9.70					
	038S0T0801	12.00					
	038S0T0802	38.00					
	038S0T0901	21.00					
	038S0T1001	11.00					
	038S0T1002	3.20					
	038S0T1101	9.30					
	038S0T1201	4.50					
	038S0T1301	13.00					
	038S0T1302	2.80					
	038S0T1401	34.00					
	038S0T1501	6.70					
	038S0T1601	11.00					
	038S0T1701	9.30					
	038S0T1801	12.00					
	038S0T1802	10.00					
	038S0T1901	33.00					
	038S0T1902	1.00					
	038S0T2001	30.00					
	038S0T2301	12.00					
	038S0T2501	13.00					
	038S0T2802	11.00					
	038S0T2901	3.60					
	038S0T2902	3.60					
	038S0T3002	6.00					
	038S0T3101	4.50					
	038S0T3401	6.60					
	038S0T3501	9.90					
	038S0T3601	30.00					
	038S0T3701	12.00					
	038S0T3801	48.00				X	
Chromium			210	420	38 leach tes		380
	038S0T3901	20.00					
	038S0T4001	17.00					
	038S0T4002	6.90					
	038S0T4101	36.00					
	038S0T4102	10.00					
	038S0T4201	40.00				X	
Cobalt			4700	110000	leach test	not avail	leach test
	038S0T1701	1.20					
	038S0T1802	2.10					
	038S0T2601	2.10					
	038S0T2701	1.90					
	038S0T2901	1.60					
	038S0T3301	37.00					
	038S0T3701	1.10					
	038S0T3801	1.00					
	038S0T4101	1.30					
Copper			110	76000	leach test	leach tes	leach test
	038S0I1001	5.40					
	038S0I1002	2.80					
	038S0S2301	4.10					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0S2302	17.00					
	038S0T0101	9.80					
	038S0T0102	1.10					
	038S0T0201	7.70					
	038S0T0301	35.00					
	038S0T0302	15.00					
	038S0T0401	11.00					
	038S0T0502	18.00					
	038S0T0601	7.00					
	038S0T0701	21.00					
	038S0T0801	2.60					
	038S0T0802	31.00					
	038S0T0901	5.40					
	038S0T0902	6.00					
	038S0T1001	6.30					
	038S0T1002	24.00					
	038S0T1101	140.00		X			
	038S0T1102	4.10					
	038S0T1201	7.40					
	038S0T1202	1.50					
	038S0T1301	76.00					
	038S0T1302	14.00					
	038S0T1401	5.20					
	038S0T1402	1.40					
	038S0T1501	43.00					
	038S0T1502	58.00					
	038S0T1601	67.00					
Copper			110	76000	leach test	leach tes	leach test
	038S0T1701	25.00					
	038S0T1702	3.90					
	038S0T1801	32.00					
	038S0T1802	100.00					
	038S0T1901	4.80					
	038S0T1902	32.00					
	038S0T2001	7.00					
	038S0T2202	36.00					
	038S0T2301	46.00					
	038S0T2501	7.30					
	038S0T2502	1.10					
	038S0T2601	3.20					
	038S0T2602	3.70					
	038S0T2702	5.70					
	038S0T2802	10.00					
	038S0T2902	35.00					
	038S0T3002	3.70					
	038S0T3101	140.00		X			
	038S0T3102	1.20					
	038S0T3301	3.30					
	038S0T3401	6.50					
	038S0T3501	11.00					
	038S0T3502	1.80					
	038S0T3601	11.00					
	038S0T3701	18.00					
	038S0T3801	28.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T3901	43.00					
	038S0T4001	59.00					
	038S0T4002	17.00					
	038S0T4101	210.00		X			
	038S0T4102	7.80					
	038S0T4201	190.00 A		X			
Cyanide (CN)			30	39000	40 LEACH		400
	038S0T0901	0.27					
	038S0T1002	0.53 A					
	038S0T3601	9.70					
	038S0T4201	0.00 NA					
Iron			23000	480000	leach test	leach tes	leach test
	038S0I1001	92.00					
	038S0I1002	35.00					
	038S0S2301	770.00					
	038S0S2302	780.00					
	038S0T0101	10,000.00					
	038S0T0102	150.00					
	038S0T0201	3,500.00					
	038S0T0301	3,400.00					
	038S0T0302	1,700.00					
Iron			23000	480000	leach test	leach tes	leach test
	038S0T0401	4,200.00					
	038S0T0402	47.00					
	038S0T0501	24.00					
	038S0T0502	210.00					
	038S0T0601	1,800.00					
	038S0T0602	92.00					
	038S0T0701	3,000.00					
	038S0T0702	18.00					
	038S0T0801	8,100.00					
	038S0T0802	710.00					
	038S0T0901	1,300.00					
	038S0T0902	76.00					
	038S0T1001	4,500.00					
	038S0T1002	1,500.00					
	038S0T1101	6,700.00					
	038S0T1102	250.00					
	038S0T1201	2,900.00					
	038S0T1202	220.00					
	038S0T1301	10,000.00					
	038S0T1302	3,700.00					
	038S0T1401	22,000.00					
	038S0T1402	14.00					
	038S0T1501	2,500.00					
	038S0T1502	860.00					
	038S0T1601	7,500.00					
	038S0T1602	24.00					
	038S0T1701	7,400.00					
	038S0T1702	680.00					
	038S0T1801	7,900.00					
	038S0T1802	6,800.00					
	038S0T1901	18,000.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T1902	1,400.00					
	038S0T2001	16,000.00					
	038S0T2002	32.00					
	038S0T2201	170.00					
	038S0T2202	350.00					
	038S0T2301	7,000.00					
	038S0T2302	87.00					
	038S0T2501	8,800.00					
	038S0T2502	85.00					
	038S0T2601	260.00					
	038S0T2602	110.00					
	038S0T2701	210.00					
	038S0T2702	120.00					
	038S0T2801	34.00					
	038S0T2802	270.00					
	038S0T2901	2,000.00					
Iron			23000	480000	leach test	leach tes	leach test
	038S0T2902	2,100.00					
	038S0T3002	180.00					
	038S0T3101	1,300.00					
	038S0T3102	160.00					
	038S0T3201	51.00					
	038S0T3202	29.00					
	038S0T3301	400.00					
	038S0T3302	100.00					
	038S0T3401	3,400.00					
	038S0T3402	130.00					
	038S0T3501	4,200.00					
	038S0T3502	150.00					
	038S0T3601	2,100.00					
	038S0T3602	37.00					
	038S0T3701	3,200.00					
	038S0T3702	41.00					
	038S0T3801	4,600.00					
	038S0T3901	8,200.00					
	038S0T4001	4,500.00					
	038S0T4002	390.00					
	038S0T4101	3,900.00					
	038S0T4102	170.00					
	038S0T4201	2,400.00					
Lead			400	920	leach test	leach tes	leach test
	038S0I1001	36.00					
	038S0I1002	12.00					
	038S0S2301	35.00					
	038S0S2302	58.00					
	038S0T0101	58.00					
	038S0T0102	5.30					
	038S0T0201	20.00					
	038S0T0301	210.00					
	038S0T0302	65.00					
	038S0T0401	46.00					
	038S0T0402	13.00					
	038S0T0501	7.60					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T0502	17.00					
	038S0T0601	74.00					
	038S0T0602	8.90					
	038S0T0701	93.00					
	038S0T0702	2.80					
	038S0T0801	3.30					
	038S0T0802	50.00					
	038S0T0901	5.80					
	038S0T0902	1.80					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Lead			400	920	leach test	leach tes	leach test
	038S0T1001	23.00					
	038S0T1002	61.00					
	038S0T1101	240.00					
	038S0T1102	11.00					
	038S0T1201	46.00					
	038S0T1202	5.20					
	038S0T1301	110.00					
	038S0T1302	29.00					
	038S0T1401	6.70					
	038S0T1402	0.80					
	038S0T1501	200.00					
	038S0T1502	37.00					
	038S0T1601	170.00					
	038S0T1602	2.70					
	038S0T1701	180.00					
	038S0T1702	71.00					
	038S0T1801	320.00					
	038S0T1802	350.00					
	038S0T1901	4.00					
	038S0T1902	250.00					
	038S0T2001	22.00					
	038S0T2002	1.00					
	038S0T2202	41.00					
	038S0T2301	110.00					
	038S0T2501	160.00 A					
	038S0T2601	43.00					
	038S0T2602	5.30					
	038S0T2701	9.80					
	038S0T2702	6.20					
	038S0T2802	10.00					
	038S0T2902	92.00					
	038S0T3002	6.80					
	038S0T3101	31.00					
	038S0T3202	4.80					
	038S0T3301	78.00					
	038S0T3302	4.80					
	038S0T3401	53.00					
	038S0T3501	75.00					
	038S0T3502	5.00					
	038S0T3601	240.00					
	038S0T3701	80.00					
	038S0T3801	110.00					
	038S0T3901	110.00					
	038S0T4001	57.00					
	038S0T4002	31.00					
	038S0T4101	360.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

			Direct Exposure	Leachability			
Parameter	Sample ID	Result	Res	Com/Ind	GW Criteri	MSW	Poor Quality
Magnesium			NOT AVAILABLE				
	038S0T4102	11.00					
	038S0T4201	270.00					
	038S0I1001	16.00					
	038S0S2301	68.00					
	038S0S2302	140.00					
	038S0T0101	260.00					
	038S0T0102	11.00					
	038S0T0201	160.00					
	038S0T0301	700.00					
	038S0T0302	380.00					
	038S0T0401	240.00					
	038S0T0601	540.00					
	038S0T0602	24.00					
	038S0T0701	750.00					
	038S0T0801	120.00					
	038S0T0802	41.00					
	038S0T0901	150.00					
	038S0T0902	11.00					
	038S0T1001	160.00					
	038S0T1002	66.00					
	038S0T1101	410.00					
	038S0T1102	25.00					
	038S0T1201	200.00					
	038S0T1202	29.00					
	038S0T1301	590.00					
	038S0T1302	79.00					
	038S0T1401	130.00					
	038S0T1501	290.00					
	038S0T1502	76.00					
	038S0T1601	430.00					
	038S0T1701	470.00					
	038S0T1702	36.00					
	038S0T1801	730.00					
	038S0T1802	1,200.00					
	038S0T1901	100.00					
	038S0T1902	560.00					
	038S0T2001	850.00 A					
	038S0T2201	16.00					
	038S0T2202	28.00					
	038S0T2301	260.00					
	038S0T2501	410.00					
	038S0T2502	16.00					
	038S0T2601	96.00					
	038S0T2602	11.00					
	038S0T2701	48.00					
	038S0T2802	17.00					
	038S0T2901	38.00					
Magnesium			NOT AVAILABLE				
	038S0T2902	290.00					
	038S0T3101	100.00					
	038S0T3102	9.40					
	038S0T3301	92.00					
	038S0T3302	14.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T3401	190.00					
	038S0T3501	440.00					
	038S0T3502	14.00					
	038S0T3601	350.00					
	038S0T3701	150.00					
	038S0T3801	170.00					
	038S0T3901	290.00					
	038S0T4001	160.00					
	038S0T4002	71.00					
	038S0T4101	250.00					
	038S0T4102	12.00					
	038S0T4201	300.00					
Manganese			1600	22000	leach test	leach tes	leach test
	038S0S2301	4.30					
	038S0S2302	4.70					
	038S0T0101	210.00					
	038S0T0102	1.70					
	038S0T0201	90.00					
	038S0T0301	63.00					
	038S0T0302	29.00					
	038S0T0401	86.00					
	038S0T0601	50.00					
	038S0T0602	2.90					
	038S0T0701	100.00					
	038S0T0801	11.00					
	038S0T0802	4.70					
	038S0T0901	14.00					
	038S0T1001	100.00					
	038S0T1002	14.00					
	038S0T1101	88.00					
	038S0T1102	3.80					
	038S0T1201	31.00					
	038S0T1202	7.70					
	038S0T1301	82.00					
	038S0T1302	18.00					
	038S0T1401	10.00					
	038S0T1402	1.20					
	038S0T1501	45.00					
	038S0T1502	5.60					
	038S0T1601	110.00					
	038S0T1602	3.10					
	038S0T1701	130.00					
Manganese			1600	22000	leach test	leach tes	leach test
	038S0T1702	8.00					
	038S0T1801	380.00					
	038S0T1901	9.40					
	038S0T1902	20.00					
	038S0T2001	50.00					
	038S0T2201	1.40					
	038S0T2202	8.00					
	038S0T2301	100.00					
	038S0T2302	1.30					
	038S0T2501	74.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T2502	1.90					
	038S0T2601	6.10					
	038S0T2602	4.00					
	038S0T2701	3.00					
	038S0T2702	1.50					
	038S0T2802	4.00					
	038S0T2901	3.10					
	038S0T2902	35.00					
	038S0T3002	2.30					
	038S0T3101	30.00					
	038S0T3102	1.90					
	038S0T3301	5.10					
	038S0T3401	80.00					
	038S0T3501	92.00					
	038S0T3502	15.00					
	038S0T3601	79.00					
	038S0T3701	100.00					
	038S0T3702	1.00					
	038S0T3801	87.00					
	038S0T3901	94.00					
	038S0T4001	76.00					
	038S0T4002	7.30					
	038S0T4101	66.00					
	038S0T4102	1.70					
	038S0T4201	34.00					
Mercury			3.4	26	2.1	0.01	21
	038S0S2302	0.09				X	
	038S0T0301	0.12				X	
	038S0T0302	0.10				X	
	038S0T0401	0.07				X	
	038S0T0402	0.82				X	
	038S0T0701	0.08				X	
	038S0T1001	0.17				X	
	038S0T1002	0.08				X	
	038S0T1101	0.22				X	
	038S0T1201	0.12				X	
	038S0T1301	0.36				X	
Mercury			3.4	26	2.1	0.01	21
	038S0T1501	0.22				X	
	038S0T1601	0.14				X	
	038S0T1702	0.07				X	
	038S0T1802	1.00				X	
	038S0T1902	0.05				X	
	038S0T2002	0.17				X	
	038S0T2301	0.07				X	
	038S0T2702	0.07				X	
	038S0T3101	0.07				X	
	038S0T3501	0.85				X	
	038S0T3502	0.09				X	
	038S0T3601	0.08				X	
	038S0T3801	0.07				X	
	038S0T3901	0.10				X	
	038S0T4001	0.08				X	

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T4101	0.23					X
Molybdenum			390	9700	leach test	not avail	leach test
	038S0T0101	2.10					
	038S0T4101	1.70					
Nickel			110	28000	130	leach tes	1300
	038S0T0201	2.00					
	038S0T0301	3.10					
	038S0T0302	3.40					
	038S0T0401	3.40					
	038S0T0701	3.30					
	038S0T0802	2.50					
	038S0T1001	3.00					
	038S0T1101	2.90					
	038S0T1301	4.30					
	038S0T1601	4.20					
	038S0T1701	4.00					
	038S0T1802	12.00					
	038S0T2301	4.80					
	038S0T3301	9.50					
	038S0T3401	2.20					
	038S0T3501	3.90					
	038S0T3601	4.10					
	038S0T3701	2.40					
	038S0T3801	4.90					
	038S0T4001	3.40					
	038S0T4101	4.90					
	038S0T4201	18.00 A					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Potassium			NOT AVAILABLE				
	038S0T1501	220.00					
	038S0T1601	220.00					
	038S0T1802	440.00					
	038S0T2901	220.00					
Sodium			NOT AVAILABLE				
	038S0I1001	120.00					
	038S0T0301	490.00					
	038S0T0302	120.00					
	038S0T0601	190.00					
	038S0T0701	140.00					
	038S0T1101	560.00					
	038S0T1301	560.00					
	038S0T1501	400.00					
	038S0T1601	320.00					
	038S0T1701	110.00					
	038S0T1801	660.00					
	038S0T1802	170.00					
	038S0T3801	160.00					
Strontium			47000 NA		leach test	not appli	leach test
	038S0S2301	1.20					
	038S0S2302	1.20					
	038S0T0101	16.00					
	038S0T0201	3.60					
	038S0T0301	8.80					
	038S0T0302	4.20					
	038S0T0401	3.80					
	038S0T0601	10.00					
	038S0T0701	9.60					
	038S0T0802	1.10					
	038S0T1001	2.40					
	038S0T1002	2.30					
	038S0T1101	8.90					
	038S0T1201	2.70					
	038S0T1301	69.00					
	038S0T1302	4.20					
	038S0T1501	5.00					
	038S0T1502	1.10					
	038S0T1601	27.00					
	038S0T1701	30.00					
	038S0T1801	5.30					
	038S0T1802	16.00					
	038S0T1902	13.00					
	038S0T2001	15.00 A					
	038S0T2301	9.10					
	038S0T2501	5.20					
	038S0T2601	4.60					
	038S0T2701	4.70					
	038S0T2802	1.20					
	038S0T2901	1.80					
	038S0T2902	7.20					
	038S0T3101	1.40					
	038S0T3301	2.70					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Strontium			47000	NA	leach test	not appli	leach test
	038S0T3401	2.70					
	038S0T3501	8.70					
	038S0T3601	12.00					
	038S0T3701	3.90					
	038S0T3801	4.00					
	038S0T3901	5.50					
	038S0T4001	5.50					
	038S0T4002	1.20					
	038S0T4101	8.00					
	038S0T4201	5.40					
Tin			44000	660000	leach test	not appli	leach test
	038S0T1101	16.00					
	038S0T2301	9.70					
	038S0T4101	30.00					
	038S0T4201	16.00 A					
Titanium		EPA III RBC	310000	8200000	not availab	not avail	not available
	038S0I1001	18.00					
	038S0I1002	2.60					
	038S0S2301	21.00					
	038S0S2302	9.50					
	038S0T0101	100.00					
	038S0T0102	5.00					
	038S0T0201	74.00					
	038S0T0301	58.00					
	038S0T0302	30.00					
	038S0T0401	80.00					
	038S0T0402	5.80					
	038S0T0501	8.70					
	038S0T0502	1.80					
	038S0T0601	40.00					
	038S0T0602	3.40					
	038S0T0701	60.00					
	038S0T0702	2.10					
	038S0T0801	84.00					
	038S0T0802	14.00					
	038S0T0901	120.00					
	038S0T0902	2.70					
	038S0T1001	75.00					
	038S0T1002	13.00					
	038S0T1101	78.00					
	038S0T1102	5.30					
	038S0T1201	49.00					
	038S0T1202	8.60					
	038S0T1301	110.00					
	038S0T1302	26.00					
	038S0T1401	130.00					
	038S0T1402	1.20					
	038S0T1502	8.20					
	038S0T1601	92.00					
	038S0T1602	1.30					
	038S0T1701	87.00					
Titanium		EPA III RBC	310000	8200000	not availab	not avail	not available

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T1702	9.60					
	038S0T1801	120.00					
	038S0T1802	120.00					
	038S0T1901	120.00					
	038S0T1902	16.00					
	038S0T2001	110.00					
	038S0T2002	1.00					
	038S0T2201	1.60					
	038S0T2202	3.40					
	038S0T2301	100.00					
	038S0T2302	1.80					
	038S0T2501	97.00					
	038S0T2502	2.90					
	038S0T2601	7.70					
	038S0T2602	21.00					
	038S0T2701	4.80					
	038S0T2702	3.40					
	038S0T2801	2.40					
	038S0T2802	4.60					
	038S0T2901	37.00					
	038S0T2902	28.00					
	038S0T3002	3.60					
	038S0T3101	34.00					
	038S0T3102	5.90					
	038S0T3201	2.20					
	038S0T3202	4.20					
	038S0T3301	11.00					
	038S0T3302	4.80					
	038S0T3401	64.00					
	038S0T3402	4.80					
	038S0T3501	72.00					
	038S0T3502	4.10					
	038S0T3601	56.00					
	038S0T3602	7.60					
	038S0T3701	80.00					
	038S0T3702	4.00					
	038S0T3801	55.00					
	038S0T3901	100.00					
	038S0T4001	71.00					
	038S0T4002	7.60					
	038S0T4101	36.00					
	038S0T4102	3.00					
	038S0T4201	30.00					

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability	
			Res	Com/Ind	GW Criteri	MSW Poor Quality
Vanadium			15	7400	980	not avail 9800
	038S0S2301	1.80				
	038S0S2302	1.60				
	038S0T0101	29.00		X		
	038S0T0201	9.30				
	038S0T0301	7.30				
	038S0T0302	3.60				
	038S0T0401	11.00				
	038S0T0601	3.20				
	038S0T0701	8.60				
	038S0T0801	23.00		X		
	038S0T0802	1.30				
	038S0T0901	34.00		X		
	038S0T1001	12.00				
	038S0T1101	14.00				
	038S0T1201	6.20				
	038S0T1301	21.00		X		
	038S0T1302	12.00				
	038S0T1401	55.00		X		
	038S0T1501	4.00				
	038S0T1601	16.00		X		
	038S0T1701	13.00				
	038S0T1702	1.60				
	038S0T1801	19.00		X		
	038S0T1802	5.20				
	038S0T1901	52.00		X		
	038S0T1902	2.00				
	038S0T2001	48.00				
	038S0T2301	17.00				
	038S0T2501	19.00				
	038S0T2901	6.10				
	038S0T2902	1.90				
	038S0T3101	4.40				
	038S0T3401	7.50				
	038S0T3501	8.80				
	038S0T3601	4.10				
	038S0T3701	10.00				
	038S0T3801	9.30				
	038S0T3901	21.00				
	038S0T4001	12.00				
	038S0T4101	5.50				
	038S0T4201	2.80				
Yttrium			NOT AVAILABLE			
	038S0T0101	3.50				
	038S0T0201	1.00				
	038S0T0301	1.60				
	038S0T0401	1.70				
	038S0T0601	1.10				
	038S0T1001	1.80				
	038S0T1101	1.80				
	038S0T1301	2.10				
	038S0T1501	1.50				
Yttrium			NOT AVAILABLE			

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability	
			Res	Com/Ind	GW Criteri MSW	Poor Quality
	038S0T1601	2.60				
	038S0T1701	2.70				
	038S0T1801	4.80				
	038S0T1802	1.80				
	038S0T2301	2.40				
	038S0T2501	2.10				
	038S0T3401	2.80				
	038S0T3501	2.30				
	038S0T3601	1.80				
	038S0T3701	2.20				
	038S0T3801	1.30				
	038S0T4001	1.40				
Zinc			23000	560000	6000 not avail	60000
	038S0I1001	38.00				
	038S0I1002	17.00				
	038S0S2301	37.00				
	038S0S2302	28.00				
	038S0T0101	35.00				
	038S0T0102	2.70				
	038S0T0201	26.00				
	038S0T0301	130.00				
	038S0T0302	35.00				
	038S0T0401	42.00				
	038S0T0402	1.30				
	038S0T0502	18.00				
	038S0T0601	37.00				
	038S0T0602	3.60				
	038S0T0701	67.00				
	038S0T0801	3.10				
	038S0T0802	54.00				
	038S0T0901	7.00				
	038S0T0902	4.00				
	038S0T1001	57.00				
	038S0T1002	49.00				
	038S0T1101	230.00				
	038S0T1102	7.90				
	038S0T1201	55.00				
	038S0T1202	4.20				
	038S0T1301	100.00				
	038S0T1302	15.00				
	038S0T1401	4.30				
	038S0T1402	1.20				
	038S0T1501	110.00				
	038S0T1601	120.00				
	038S0T1701	110.00				
	038S0T1702	19.00				
	038S0T1801	66.00				
	038S0T1802	96.00				
	038S0T1902	53.00				
	038S0T2001	14.00				
	038S0T2202	42.00				
	038S0T2301	140.00				
Zinc			23000	560000	6000 not avail	60000

EPA DATA

INORGANIC CONCENTRATIONS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
	038S0T2302	1.40					
	038S0T2501	30.00					
	038S0T2502	2.90					
	038S0T2601	9.40					
	038S0T2602	3.20					
	038S0T2701	5.00					
	038S0T2702	4.60					
	038S0T2802	12.00					
	038S0T2902	100.00					
	038S0T3002	5.60					
	038S0T3101	73.00					
	038S0T3102	10.00					
	038S0T3202	1.90					
	038S0T3301	44.00					
	038S0T3302	3.20					
	038S0T3401	27.00					
	038S0T3402	7.80					
	038S0T3501	86.00					
	038S0T3502	3.80					
	038S0T3601	98.00					
	038S0T3701	19.00					
	038S0T3702	6.20					
	038S0T3801	99.00					
	038S0T3901	290.00					
	038S0T4001	93.00					
	038S0T4002	26.00					
	038S0T4101	200.00					
	038S0T4102	36.00					
	038S0T4201	280.00					

EPA DATA

SVOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Acenaphthene			1900000	18000000	2100	700	21000
	038S0T050	1,400.00 J				X	
Anthracene			1.8E+07	260000000	2500000	700	25000000
	038S0T050	2,000.00 J				X	
Benzo(a)anthracene			1400	5000	3200	700	32000
	038S0T050	740.00 J				X	
	038S0T110	370.00 J					
	038S0T270	2,600.00 J	X			X	
Benzo(a)pyrene			100	500	8000	1200	80000
	038S0T050	380.00 J	X				
	038S0T270	2,200.00 J	X	X		X	
Benzo(b)fluoranthene			1400	4800	10000	1600	100000
	038S0T050	530.00 J					
	038S0T110	670.00 J					
	038S0T170	470.00 J					
	038S0T270	3,800.00	X			X	
	038S0T380	230.00 J					
Benzo(g,h,i)perylene			2300000	41000000	32000000	4800	320000000
	038S0T270	1,000.00 J					
	038S0T380	260.00 J					
Chrysene			140000	450000	77000	700	770000
	038S0T050	1,100.00 J				X	
	038S0T110	470.00 J					
	038S0T270	2,200.00 J				X	
Fluoranthene			2900000	48000000	1200000	1300	12000000
	038S0T050	1,700.00 J				X	
	038S0T110	490.00 J					
	038S0T270	3,700.00				X	
Fluorene			2200000	28000000	160000	17000	1600000
	038S0T050	790.00 J					
Indeno(1,2,3-cd)pyrene			1500	5300	28000	4300	280000
	038S0T270	1,000.00 J					
Naphthalene			40000	270000	1700	2200	17000
	038S0T050	440.00 J					
Phenanthrene			2000000	30000000	250000	700	2500000
	038S0T050	17,000.00				X	
	038S0T270	340.00 J					
Pyrene			2200000	37000000	880000	1300	8800000
	038S0T050	1,800.00 J				X	
	038S0T110	480.00 J					
	038S0T270	3,500.00				X	

EPA DATA

PESTICIDE CONCENTRATIONS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
4,4'-DDE			3300	13000	18000	100	180000
	038S0T0301	10.00 J					
	038S0T0401	3.80 J					
	038S0T0701	15.00 JN					
	038S0T1501	5.80 J					
	038S0T3101	120.00				X	
	038S0T3601	46.00					
	038S0T3701	100.00					
4,4'-DDT			3300	1300	11000	60	110000
	038S0T0401	8.00 J					
	038S0T3101	56.00					
	038S0T3501	11.00 J					
	038S0T3701	45.00					
Aroclor-1254			500	2100	17000	3	170000
	038S0S2301	81.00 J				X	
	038S0I1001	90.00 J				X	
	038S0T0101	810.00	X			X	
	038S0T1801	83.00 J				X	
beta-BHC			600	2100	1	3	10
	038S0T4201	56.00 N			X	X	X
delta-BHC			22000	420000	200	not avail	2000
	038S0T4201	300.00 N			X		
Dieldrin			70	300	4	0.1	40
	038S0T0301	20.00 J			X	X	
	038S0T0401	3.10 J				X	
	038S0T0701	9.00 JN			X	X	
	038S0T1501	40.00 J			X	X	
	038S0T3701	84.00	X		X	X	X
	038S0T3801	5.30 J			X	X	
Endosulfan I			410000	6700000	3800	0.8	38000
	038S0T4201	7.40 JN				X	
Endosulfan II	USE ENDOSULFAN I		410000	6700000	3800	0.8	38000
	038S0T4201	11.00 JN				X	
Endosulfan sulfa	USE ENDOSULFAN I		410000	6700000	3800	0.8	38000
	038S0T4201	70.00 N				X	
Endrin			21000	340000	1000	1	10000
	038S0T4201	7.10 JN				X	

EPA DATA

VOC COMPOUNDS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
1,1,1-Trichloroethane			400000	3300000	1900	2600	19000
	038S0T0502	310.00					
	038S0T2902	7.80 J					
1,2-Dichlorobenzene			650000	4600000	17000	2800	170000
	038S0T0502	280.00					
Tetrachloroethene			8900	17000	30	100	300
	038S0I1001	9.20 J					
	038S0I1002	1,100.00 J			X	X	X
	038S0T0502	810.00 J			X	X	X
	038S0T2802	4.80 J					
	038S0T2902	34.00 J			X		
	038S0T3002	27.00 J					
	038S0T3101	8.60 J					
	038S0T4102	8.20 J					
Toluene			380000	2600000	500	5600	5000
	038S0T0601	8.70 J					
	038S0T2301	6.90 J					
	038S0T3101	5.80 J					
	038S0T3601	13.00 J					
	038S0T3801	5.90 J					
Trichloroethene			6000	8500	30	900	300
	038S0T0502	200.00			X		
	038S0T4102	6.70 J					

F-3:
IWTP Results

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Aluminum			72000	NA	leach test	leach tes	leach test
	036S073C02	297.00					
	036S073C04	366.00					
	036S074C02	649.00					
	036S074C04	1,420.00					
	036S074N02	2,030.00					
	036S074N04	29.40					
	036S074W02	4,500.00					
	036S074W04	698.00					
	036S075C02	1,330.00 J					
	036S075C04	514.00					
	036S075E02	1,440.00 J					
	036S075E06	959.00 J					
	036S076C02	3,130.00 J					
	036S076E02	388.00 J					
	036S076E04	97.80 J					
	036S076S02	409.00 J					
	036S076W02	200.00 J					
	036S076W04	994.00 J					
	036S077C02	273.00					
	036S077C04	2,500.00					
	036S077N02	17.20 J					
	036S077N04	15.70 J					
	036S077S02	1,710.00					
	036S077S04	22.80 J					
	036S077W02	890.00 J					
	036S077W04	755.00					
	036S078C02	524.00					
	036S078C04	4,330.00					
	036S078E04	25.80 J					
	036S078S02	1,150.00					
	036S078W02	5,010.00					
	036S078W04	36.30					
	036S079C02	82.20					
	036S079C04	17.30 J					
	036S079W02	963.00					
	036S079W04	31.00 J					
	036S080C02	292.00					
	036S080S02	1,100.00					
	036S081C02	1,920.00					
	036S081C04	124.00					
	036S081S03	14.00 J					
	036S081W02	44.70					
	036S081W04	111.00					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Antimony			26	240		5 leach tes	50
	036S074C02	1.80 J					
	036S077S02	2.60 J					
	036S078C04	2.20 J					
	036S080S02	2.70 J					
Arsenic			0.8	3.7		29 leach tes	290
	036S073C02	0.63 J					
	036S073C04	0.55 J					
	036S074C02	1.20	X				
	036S074C04	2.00	X				
	036S074N02	6.40	X	X			
	036S074N04	0.16 J					
	036S074W02	3.60	X				
	036S074W04	0.22 J					
	036S075C02	0.85 J	X				
	036S075E02	5.10 J	X	X			
	036S075E06	2.60 J	X				
	036S076C02	2.00 J	X				
	036S076E02	0.46 J					
	036S076E04	0.32 J					
	036S076S02	1.30 J	X				
	036S076W02	0.70 J					
	036S076W04	1.30 J	X				
	036S077C02	0.33 J					
	036S077C04	1.30 J	X				
	036S077S02	1.30 J	X				
	036S077W02	0.91 J	X				
	036S077W04	0.71 J					
	036S078C02	0.90 J	X				
	036S078C04	0.43 J					
	036S078E02	3.20 J	X				
	036S078S02	1.10 J	X				
	036S078W02	0.21 J					
	036S078W04	0.22 J					
	036S080C02	1.30 J	X				
	036S080S02	0.47 J					
	036S081C02	0.72 J					
Barium			110	8700		1600 leach tes	16000
	036S073C02	11.80 J					
	036S073C04	7.30 J					
	036S074C02	23.30 J					
	036S074C04	29.60					
	036S074N02	102.00					
	036S074N04	11.90 J					
	036S074W02	41.60					
	036S074W04	19.50 J					
	036S075C02	17.00 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability	
			Res	Com/Ind	GW Criteria	MSW Poor Quality
Barium			110	8700	1600 leach tes	16000
	036S075C04	11.20 J				
	036S075E02	62.50				
	036S075E06	37.60				
	036S076C02	44.60				
	036S076E02	6.80 J				
	036S076E04	2.50 J				
	036S076S02	13.40 J				
	036S076W02	4.50 J				
	036S076W04	23.70 J				
	036S077C02	11.50 J				
	036S077C04	53.50				
	036S077N02	0.37 J				
	036S077N04	0.28 J				
	036S077S02	20.70 J				
	036S077S04	0.65 J				
	036S077W02	9.50 J				
	036S077W04	11.80 J				
	036S078C02	14.00 J				
	036S078C04	18.70 J				
	036S078E02	21.50 J				
	036S078E04	1.40 J				
	036S078S02	19.90 J				
	036S078W02	2.70 J				
	036S078W04	1.10 J				
	036S079C02	1.70 J				
	036S079C04	0.34 J				
	036S079W02	28.80 J				
	036S079W04	0.76 J				
	036S080C02	20.50 J				
	036S080S02	28.10 J				
	036S081C02	10.70 J				
	036S081C04	1.10 J				
	036S081S03	0.71 J				
	036S081W02	0.54 J				
	036S081W04	0.30 J				
Beryllium			120	800	63 leach tes	630
	036S074C02	0.12 J				
	036S074N02	0.31 J				
	036S076C02	0.28 J				
	036S077C04	0.38 J				
Cadmium			75	1300	8 leach tes	80
	036S074C02	0.64				
	036S074C04	0.34 J				
	036S074N02	1.20				
	036S075C02	1.70				
	036S075C04	4.90				

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Cadmium			75	1300		8 leach tes	80
	036S075E02	2.60					
	036S076C02	3.20					
	036S076S02	0.97					
	036S076W02	4.40					
	036S076W04	4.90					
	036S077C04	1.30					
	036S078C04	0.83					
Calcium			NONE AVAILABLE				
	036S073C02	422.00 J					
	036S073C04	490.00 J					
	036S074C02	1,670.00					
	036S074C04	22,400.00					
	036S074N02	1,980.00					
	036S074N04	28.90 J					
	036S074W02	60,400.00					
	036S074W04	9,010.00					
	036S075C02	995.00					
	036S075C04	1,520.00					
	036S075E02	1,140.00					
	036S075E06	2,120.00					
	036S076C02	11,000.00					
	036S076E02	1,600.00					
	036S076E04	891.00					
	036S076S02	509.00 J					
	036S076W02	308.00 J					
	036S076W04	2,210.00					
	036S077C02	5,210.00					
	036S077C04	14,200.00					
	036S077N02	20.30 J					
	036S077N04	9.60 J					
	036S077S02	26,300.00					
	036S077S04	30.20 J					
	036S077W02	551.00 J					
	036S077W04	3,830.00					
	036S078C02	3,490.00					
	036S078C04	21,600.00					
	036S078E02	1,160.00					
	036S078E04	98.10 J					
	036S078S02	1,930.00					
	036S078W02	593.00 J					
	036S078W04	32.30 J					
	036S079C02	227.00 J					
	036S079C04	16.80 J					
	036S079W02	3,670.00					
	036S079W04	96.90 J					
	036S080C02	859.00					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Calcium			NONE AVAILABLE				
	036S080S02	17,000.00					
	036S081C02	7,920.00					
	036S081C04	138.00 J					
	036S081S03	20.60 J					
	036S081W02	30.60 J					
	036S081W04	35.80 J					
Chromium			210	420	38 leach tes		380
	036S073C02	1.70					
	036S073C04	1.40 J					
	036S074C02	2.40					
	036S074C04	2.00					
	036S074N02	6.70					
	036S074N04	1.30					
	036S074W02	8.70					
	036S074W04	1.50 J					
	036S075C02	29.50 J					
	036S075C04	9.90					
	036S075E02	6.60 J					
	036S075E06	10.90 J					
	036S076C02	4.40 J					
	036S076E02	1.10 J					
	036S076E04	1.50 J					
	036S076S02	3.10 J					
	036S076W02	8.80 J					
	036S076W04	11.10 J					
	036S077C02	1.70					
	036S077C04	9.90					
	036S077N02	5.10					
	036S077N04	3.00					
	036S077S02	18.50					
	036S077S04	5.50					
	036S077W02	2.10					
	036S077W04	2.00					
	036S078C02	2.20					
	036S078C04	5.70 J					
	036S078S02	8.80					
	036S078W02	8.60					
	036S078W04	0.77 J					
	036S079C04	1.20 J					
	036S079W02	7.50					
	036S079W04	0.76 J					
	036S080C02	2.10					
	036S080S02	3.40					
	036S081C02	12.30					
	036S081C04	7.20					
	036S081S03	1.10 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Cobalt			4700	110000	leach test	not avail	leach test
	036S073C02	0.56 J					
	036S073C04	0.37 J					
	036S074C04	0.70 J					
	036S074N02	5.30 J					
	036S074W02	1.20 J					
	036S074W04	0.41 J					
	036S075C02	0.25 J					
	036S075E02	1.50 J					
	036S075E06	10.00 J					
	036S076C02	0.41 J					
	036S076S02	0.35 J					
	036S076W04	0.34 J					
	036S077C02	0.35 J					
	036S077C04	0.83 J					
	036S077S02	0.38 J					
	036S077W04	0.49 J					
	036S078C04	0.51 J					
	036S078E02	0.75 J					
	036S078S02	0.78 J					
	036S080S02	0.49 J					
Copper			110	76000	leach test	leach tes	leach test
	036S073C02	21.40					
	036S073C04	27.10					
	036S074C02	15.90					
	036S074C04	31.50					
	036S074N02	607.00	X				
	036S074N04	1.20 J					
	036S074W02	117.00	X				
	036S074W04	10.40					
	036S075C02	12.30					
	036S075C04	23.80					
	036S075E02	391.00	X				
	036S075E06	129.00	X				
	036S076C02	28.90					
	036S076E02	32.60					
	036S076E04	79.70					
	036S076S02	12.70					
	036S076W02	16.20					
	036S076W04	20.30					
	036S077C02	16.10					
	036S077C04	26.00					
	036S077N02	0.79 J					
	036S077N04	5.20					
	036S077S02	2.60 J					
	036S077S04	0.86 J					
	036S077W02	4.40					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Copper			110	76000	leach test	leach tes	leach test
	036S077W04	5.70					
	036S078C02	15.60					
	036S078C04	8.00					
	036S078E02	264.00		X			
	036S078E04	3.70					
	036S078S02	75.90					
	036S078W02	1.20 J					
	036S078W04	2.40					
	036S079C02	13.60					
	036S079C04	0.98 J					
	036S079W02	5.70					
	036S079W04	0.44 J					
	036S080C02	8.00					
	036S080S02	5,340.00		X			
	036S081C02	17.60					
	036S081C04	0.46 J					
	036S081S03	2.50 J					
	036S081W02	1.70 J					
Cyanide (CN)			30	39000	40 leach tes		400
	036S074N02	0.22 J					
	036S075C02	0.23 J					
	036S075E06	0.48 J					
	036S076E04	0.21 J					
	036S076S02	0.48					
	036S078E02	0.66					
Iron			23000	480000	leach test	leach tes	leach test
	036S073C02	763.00					
	036S073C04	856.00					
	036S074C02	629.00					
	036S074C04	2,230.00					
	036S074N02	24,900.00		X			
	036S074N04	106.00					
	036S074W02	3,880.00					
	036S074W04	893.00					
	036S075C02	706.00 J					
	036S075C04	616.00 J					
	036S075E02	4,380.00 J					
	036S075E06	32,900.00 J		X			
	036S076C02	2,100.00 J					
	036S076E02	287.00 J					
	036S076E04	368.00 J					
	036S076S02	598.00 J					
	036S076W02	504.00 J					
	036S076W04	1,190.00 J					
	036S077C02	993.00 J					
	036S077C04	2,010.00 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Iron			23000	480000	leach test	leach tes	leach test
	036S077N02	50.20 J					
	036S077N04	71.40 J					
	036S077S02	1,130.00					
	036S077S04	68.00 J					
	036S077W02	1,250.00 J					
	036S077W04	795.00					
	036S078C02	1,070.00					
	036S078C04	2,800.00					
	036S078E04	87.70 J					
	036S078S02	1,560.00					
	036S078W02	6,130.00					
	036S078W04	44.40					
	036S079C02	519.00 J					
	036S079C04	25.10					
	036S079W02	342.00 J					
	036S079W04	33.10 J					
	036S080C02	285.00					
	036S080S02	3,800.00					
	036S081C02	3,010.00 J					
	036S081C04	212.00 J					
	036S081S03	26.00					
	036S081W02	70.30					
	036S081W04	84.40					
Lead			400	920	leach test	leach tes	leach test
	036S073C02	103.00					
	036S073C04	160.00					
	036S074C02	146.00					
	036S074C04	214.00					
	036S074N02	949.00	X	X			
	036S074N04	92.10					
	036S074W02	408.00	X				
	036S074W04	226.00					
	036S075C02	56.50 J					
	036S075C04	62.40 J					
	036S075E02	579.00 J	X				
	036S075E06	62.10 J					
	036S076C02	104.00 J					
	036S076E02	73.50 J					
	036S076E04	44.30 J					
	036S076S02	128.00 J					
	036S076W02	32.70 J					
	036S076W04	113.00 J					
	036S077C02	91.10 J					
	036S077C04	160.00 J					
	036S077N02	2.00 J					
	036S077N04	0.24 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Lead			400	920	leach test	leach tes	leach test
	036S077S02	6.60 J					
	036S077S04	0.95 J					
	036S077W02	35.30 J					
	036S077W04	31.40					
	036S078C02	74.60					
	036S078C04	49.20					
	036S078E04	15.70 J					
	036S078S02	120.00					
	036S078W02	2.50 J					
	036S078W04	13.00					
	036S079C02	16.60 J					
	036S079C04	0.26 J					
	036S079W02	29.00 J					
	036S079W04	0.38 J					
	036S080C02	114.00					
	036S080S02	139.00					
	036S081C02	54.50 J					
	036S081C04	6.80 J					
	036S081S03	1.30					
	036S081W02	12.00					
	036S081W04	2.00					
Magnesium			NOT AVAILABLE				
	036S073C02	71.30 J					
	036S073C04	98.80 J					
	036S074C02	237.00 J					
	036S074C04	412.00 J					
	036S074N02	612.00 J					
	036S074N04	6.20 J					
	036S074W02	14,400.00					
	036S074W04	911.00 J					
	036S075C02	165.00 J					
	036S075C04	201.00 J					
	036S075E02	269.00 J					
	036S075E06	379.00 J					
	036S076C02	477.00 J					
	036S076E02	150.00 J					
	036S076E04	94.40 J					
	036S076S02	37.80 J					
	036S076W02	31.30 J					
	036S076W04	109.00 J					
	036S077C02	170.00 J					
	036S077C04	2,050.00					
	036S077S02	5,100.00					
	036S077W02	114.00 J					
	036S077W04	160.00 J					
	036S078C02	164.00 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Magnesium			NOT AVAILABLE				
	036S078C04	662.00 J					
	036S078E02	303.00 J					
	036S078E04	8.60 J					
	036S078S02	382.00 J					
	036S078W02	157.00 J					
	036S078W04	4.40 J					
	036S079C02	17.70 J					
	036S079C04	4.20 J					
	036S079W02	669.00 J					
	036S079W04	10.90 J					
	036S080C02	77.60 J					
	036S080S02	478.00 J					
	036S081C02	197.00 J					
	036S081C04	13.00 J					
	036S081S03	4.30 J					
	036S081W02	9.00 J					
	036S081W04	4.70 J					
Manganese			1600	22000	leach test	leach tes	leach test
	036S073C02	13.20					
	036S073C04	16.40					
	036S074C02	59.90					
	036S074C04	69.10					
	036S074N02	185.00					
	036S074N04	2.80					
	036S074W02	232.00					
	036S074W04	26.40					
	036S075C02	97.50					
	036S075C04	24.40 J					
	036S075E02	63.50					
	036S075E06	987.00					
	036S076C02	184.00					
	036S076E02	9.50					
	036S076E04	21.30					
	036S076S02	30.30					
	036S076W02	8.60					
	036S076W04	37.30					
	036S077C02	37.30 J					
	036S077C04	154.00 J					
	036S077N02	2.10 J					
	036S077N04	0.47 J					
	036S077S02	71.50 J					
	036S077S04	4.10 J					
	036S077W02	19.80					
	036S077W04	18.00					
	036S078C02	20.10					
	036S078C04	32.80					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Manganese			1600	22000	leach test	leach tes	leach test
	036S078E02	25.30					
	036S078E04	3.40					
	036S078S02	84.80					
	036S078W02	6.70					
	036S078W04	1.40					
	036S079C02	8.30 J					
	036S079C04	0.58 J					
	036S079W02	47.50 J					
	036S079W04	0.89 J					
	036S080C02	18.60					
	036S080S02	20.90					
	036S081C02	39.30 J					
	036S081C04	2.80 J					
	036S081S03	0.25 J					
	036S081W02	2.90					
	036S081W04	0.35 J					
Mercury			3.4	26	2.1	0.01	21
	036S073C04	0.14				X	
	036S074C02	0.15				X	
	036S074N02	0.44				X	
	036S074W02	0.07				X	
	036S075C04	0.09				X	
	036S075E02	0.34				X	
	036S076C02	0.15				X	
	036S076E04	0.08				X	
	036S076S02	0.09				X	
	036S076W04	0.14				X	
	036S077C04	0.09				X	
	036S077W04	0.15				X	
	036S078C02	0.06				X	
	036S078E02	0.10				X	
	036S078S02	0.09				X	
	036S080S02	0.79				X	
Nickel			110	28000	130 leach tes		1300
	036S073C02	1.80 J					
	036S074C04	1.50 J					
	036S074N02	10.70					
	036S074W02	3.70 J					
	036S075C02	3.70 J					
	036S075E02	8.00					
	036S075E06	16.10					
	036S076C02	1.00 J					
	036S077C04	2.40 J					
	036S077S02	2.00 J					
	036S078C02	2.40 J					
	036S078E02	2.90 J					
	036S079W02	2.00 J					
	036S080S02	2.00 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Potassium			NOT AVAILABLE				
	036S074C02	94.20 J					
	036S074C04	158.00 J					
	036S074N02	127.00 J					
	036S074W02	47.20 J					
	036S075C02	40.30 J					
	036S075C04	65.70 J					
	036S075E02	99.10 J					
	036S075E06	211.00 J					
	036S076C02	484.00 J					
	036S076E02	43.90 J					
	036S076E04	39.20 J					
	036S076S02	31.70 J					
	036S076W04	26.10 J					
	036S077C04	366.00 J					
	036S077S02	125.00 J					
	036S077W02	35.70 J					
	036S077W04	60.30 J					
	036S078C02	103.00 J					
	036S078C04	167.00 J					
	036S078E02	84.50 J					
	036S078S02	86.80 J					
	036S078W02	43.90 J					
	036S078W04	15.80 J					
	036S079C04	39.50 J					
	036S079W02	223.00 J					
	036S080S02	115.00 J					
	036S081C02	54.90 J					
	036S081S03	40.40 J					
Selenium			390	10000	5 leach tes		50
	036S074N04	0.17 J					
	036S076E02	0.18 J					
	036S076S02	0.15 J					
	036S077C04	0.27 J					
	036S078E02	0.19 J					
	036S078W02	4.10 J					
	036S080C02	0.22 J					
Sodium			NOT AVAILABLE				
	036S073C02	65.40 J					
	036S073C04	29.00 J					
	036S074C02	22.50 J					
	036S074C04	222.00 J					
	036S074N02	46.80 J					
	036S074N04	14.60 J					
	036S074W02	90.70 J					
	036S074W04	45.70 J					
	036S075C02	20.20 J					
	036S075C04	30.20 J					
	036S075E02	38.70 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Sodium			NOT AVAILABLE				
	036S075E06	81.80 J					
	036S076C02	110.00 J					
	036S076E02	19.10 J					
	036S076E04	11.30 J					
	036S076S02	15.60 J					
	036S076W02	9.30 J					
	036S076W04	18.30 J					
	036S077C02	12.90 J					
	036S077C04	83.30 J					
	036S077N02	8.10 J					
	036S077N04	7.80 J					
	036S077S02	36.00 J					
	036S077S04	8.30 J					
	036S077W02	18.90 J					
	036S077W04	15.50 J					
	036S078C02	27.10 J					
	036S078C04	189.00 J					
	036S078E02	29.70 J					
	036S078E04	9.00 J					
	036S078S02	77.70 J					
	036S078W02	16.30 J					
	036S078W04	6.00 J					
	036S079C02	10.60 J					
	036S079C04	4.80 J					
	036S079W02	45.70 J					
	036S079W04	10.80 J					
	036S080C02	29.80 J					
	036S080S02	76.00 J					
	036S081C02	59.60 J					
	036S081C04	10.70 J					
	036S081S03	10.80 J					
	036S081W02	8.10 J					
	036S081W04	8.00 J					
Thallium			NOT AVAILABLE				
	036S077S04	0.46 J					
	036S077W02	0.28 J					
	036S078E02	0.38 J					
	036S079W04	0.47 J					
	036S081C04	0.47 J					
Vanadium			15	7400	980 not avail		9800
	036S073C02	1.50 J					
	036S073C04	0.84 J					
	036S074C02	1.70 J					
	036S074C04	3.20 J					
	036S074N02	9.90					
	036S074W02	7.30 J					
	036S074W04	1.60 J					
	036S075C02	1.80 J					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Vanadium			15	7400	980	not avail	9800
	036S075E02	4.40 J					
	036S075E06	21.50		X			
	036S076C02	4.10 J					
	036S076E02	0.55 J					
	036S076S02	1.10 J					
	036S076W04	2.30 J					
	036S077C02	1.00 J					
	036S077C04	2.50 J					
	036S077N02	0.51 J					
	036S077S02	2.60 J					
	036S077S04	0.56					
	036S077W02	3.00 J					
	036S077W04	2.10 J					
	036S078C02	1.80 J					
	036S078C04	6.90 J					
	036S078E02	1.60 J					
	036S078S02	2.00 J					
	036S078W02	15.10 J		X			
	036S078W04	0.30 J					
	036S080C02	1.00 J					
	036S080S02	3.00 J					
	036S081C02	6.60 J					
Zinc			23000	560000	6000	not avail	60000
	036S073C02	32.10					
	036S073C04	33.00					
	036S074C02	63.90					
	036S074C04	81.10					
	036S074N02	1,180.00					
	036S074N04	1.70 J					
	036S074W02	186.00					
	036S074W04	62.30					
	036S075C02	90.90					
	036S075C04	44.00					
	036S075E02	491.00					
	036S075E06	29.90					
	036S076C02	77.20					
	036S076E02	27.80					
	036S076E04	56.40					
	036S076S02	47.90					
	036S076W02	29.70					
	036S076W04	53.40					
	036S077C02	27.40					
	036S077C04	95.30					
	036S077N02	1.20 J					
	036S077N04	2.00 J					
	036S077S02	10.90					
	036S077S04	2.50 J					
	036S077W02	16.30					

ITWP LINE DATA

INORGANIC COMPOUNDS DETECTED ABOVE CRQLs (mg/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
Zinc			23000	560000	6000	not avail	60000
	036S077W04	23.80					
	036S078C02	46.80					
	036S078C04	28.40					
	036S078E02	76.30 J					
	036S078E04	4.80					
	036S078S02	102.00					
	036S078W02	0.80 J					
	036S078W04	15.30					
	036S079C02	6.60					
	036S079C04	1.50 J					
	036S079W02	10.10					
	036S079W04	2.50 J					
	036S080C02	59.00					
	036S080S02	92.60					
	036S081C02	36.90					
	036S081C04	2.80 J					
	036S081S03	3.00 J					
	036S081W02	2.40 J					
	036S081W04	0.87 J					

IWTP LINE DATA

PESTICIDE CONCENTRATIONS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteria	MSW	Poor Quality
4,4'-DDD			4600	18000	4000	100	40000
	036S074C04	11.00 J					
	036S078W02	3.50 J					
4,4'-DDE			3300	13000	19000	100	180000
	036S074C04	88.00 J					
	036S074W02	12.00					
	036S077C04	140.00 J				X	
	036S078W02	8.10					
4,4'-DDT			3300	1300	11000	60	110000
	036S074C04	63.00 J				X	
	036S075C02	1.30 J					
	036S077C04	20.00					
	036S078W02	17.00					
alpha-Chlordane	TOTAL!!!		3100	12000	9600	3	96000
	036S078W02	0.46 J					
Aroclor-1254			500	2100	17000	2	170000
	036S077C04	30.00 J				X	
Aroclor-1260			500	2100	17000	2	170000
	036S077C04	42.00				X	
	036S080C02	25.00 J				X	
Dieldrin			70	300	4	0.1	40
	036S075E02	1.40 J				X	
	036S078C04	1.60 J				X	
	036S078E02	0.94 J				X	
	036S078W02	15.00 J				X	
Endosulfan I			410000	6700000	3800	0.8	38000
	036S074C04	2.00 J				X	
Endrin			21000	340000	1000	1	10000
	036S074C02	1.40 J				X	
	036S074C04	13.00				X	
	036S075C02	2.70 J				X	
	036S075E02	9.90				X	
	036S075E06	3.40 J				X	
	036S076C02	1.80 J				X	
	036S076E02	3.40				X	
	036S076W04	0.70 J					
	036S078C04	1.10 J				X	
	036S078E02	7.80				X	
	036S078W02	3.30 J				X	
Heptachlor epoxide			100	400	600	6	6000
	036S074C04	1.00 J					
	036S074W04	2.60 J					
	036S075E02	0.58 J					

IWTP LINE DATA

SVOC CONCENTRATIONS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Acenaphthylene			1100000	1E+07	27000	700	270000
	036S074C04	1800.00				X	
	036S074W02	240.00 J					
	036S077W02	370.00					
Anthracene			1.8E+07	3E+08	2500000	700	25000000
	036S074C04	1000.00 J				X	
	036S077W02	180.00 J					
Benzo(a)anthracene			1400	5000	3200	400	32000
	036S073C02	210.00 J					
	036S074C02	270.00 J					
	036S074C04	4500.00	X		X	X	
	036S074W02	280.00 J					
	036S075C02	360.00 J					
	036S077W02	370.00					
Benzo(a)pyrene			100	500	8000	1200	80000
	036S073C02	210.00 J	X				
	036S074C02	270.00 J	X				
	036S074C04	4500.00	X	X		X	
	036S074W02	350.00 J	X				
	036S075C02	310.00 J	X				
	036S076W02	180.00 J	X				
	036S077W02	510.00	X	X			
Benzo(b)fluoranthene			1400	4800	10000	1600	100000
	036S073C02	450.00					
	036S073C04	190.00 J					
	036S074C02	530.00					
	036S074C04	8300.00	X	X		X	
	036S074W02	600.00					
	036S076W02	410.00					
	036S077W02	870.00					
	036S080S02	200.00 J					
Benzo(g,h,i)perylene			2300000	4E+07	32000000	4800	320000000
	036S074C04	1900.00					
	036S077W02	410.00					
Chrysene			140000	450000	77000	700	770000
	036S073C02	210.00 J					
	036S074C02	290.00 J					
	036S074C04	4200.00				X	
	036S074W02	290.00 J					
	036S075C02	330.00 J					
	036S077W02	330.00 J					
Dibenz(a,h)anthracene			100	500	30000	4700	300000
	036S074C04	800.00 J	X	X			

IWTP LINE DATA

SVOC CONCENTRATIONS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Result	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Fluoranthene			2900000	5E+07	1200000	1300	12000000
	036S073C02	300.00 J					
	036S074C02	450.00					
	036S074C04	6700.00				X	
	036S074W02	360.00 J					
	036S075C02	340.00 J					
	036S077W02	300.00 J					
Indeno(1,2,3-cd)pyrene			1500	5300	28000	4300	280000
	036S074C04	1700.00		X			
	036S077W02	380.00					
Phenanthrene			2000000	3E+07	250000	700	2500000
	036S074C02	210.00 J					
	036S074C04	3100.00				X	
Pyrene			2200000	4E+07	880000	1300	8800000
	036S073C02	310.00 J					
	036S074C02	450.00					
	036S074C04	9300.00				X	
	036S074W02	410.00					
	036S075C02	500.00					
	036S077W02	430.00					

IWTP LINE DATA

VOC CONCENTRATIONS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Results	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
1,1,1-Trichloroethane			400000	3300000	1900	2600	19000
	036S075E06	6.00 J					
Acetone			780000	5500000	2800	6800	28000
	036S073C04	230.00					
	036S074C02	840.00 J					
	036S074C04	200.00					
	036S074N02	35.00					
	036S074N04	210.00 J					
	036S074W0	490.00					
	036S074W0	61.00					
	036S075E06	160.00					
	036S077W0	22.00					
	036S078C02	500.00 J					
	036S078C04	94.00					
	036S078S02	8600.00			X	X	
	036S078W0	95.00					
	036S078W0	38.00					
	036S079C04	11.00					
	036S080C02	200.00					
	036S080S02	35.00					
	036S081C02	83.00					
	036S081C04	23.00					
Methylene chloride			16000	23000	20	7300	200
	036S073C02	730.00 J			X		X
	036S074C02	4.00 J					
	036S074C04	7.00 J					
	036S076E02	6.00 J					
	036S077C02	6.00 J					
	036S077C04	6.00 J					
	036S077S02	6.00 J					
	036S078C02	6.00 J					
	036S078C04	5.00 J					
	036S078E02	4.00 J					
	036S078W0	4.00 J					
	036S079C02	4.00 J					
	036S079C04	3.00 J					
	036S079W0	5.00 J					
	036S079W0	5.00 J					
	036S080S02	4.00 J					
	036S081C04	4.00 J					
Tetrachloroethene			8900	17000	30	100	300
	036S075E06	19.00					
	036S076S02	3.00 J					
Toluene			380000	2600000	500	5600	5000
	036S073C04	18.00 J					
	036S074C02	2.00 J					
	036S078C02	3.00 J					

IWTP LINE DATA

VOC CONCENTRATIONS DETECTED ABOVE CRQLs (ug/kg) AND COMPARED TO SCTLs

Parameter	Sample ID	Results	Direct Exposure		Leachability		
			Res	Com/Ind	GW Criteri	MSW	Poor Quality
Trichloroethene			6000	8500	30	900	300
	036S076C02	10.00 J					
	036S076S02	8.00 J					
	036S076W0	6.00 J					
	036S078C02	5.00 J					
	036S080S02	14.00					

F-4:
Chromium Resampling Event

CHROMIUM ANALYSIS
mg/kg

			Direct Exposure		Leachability		
Sample ID		Result	Res	Com/Ind	GW Criteri	MSW	Poor Quality
Chromium			210	420	38	leach test	380
038S013A02	Chromium	40.10 J			X		
038S013B02	Chromium	383.00 J		X	X		X
038S013B02	Chromium	0.16					
038S014A02	Chromium	0.99 J					

Appendix G
Chromium Leaching Evaluation

Section 4 discusses exceedances of soil leaching values defined in FAC 62-777 for the protection of groundwater and the protection of marine surface water. Chromium concentrations beneath the Building 71 foundation significantly exceeded the protection of groundwater standard (SL-GC), and therefore leaching studies were performed to assess overall threat to groundwater from chromium in this area.

In order to quantify the potential threat to groundwater from chromium, samples were collected from the area exhibiting the highest subsurface chromium concentrations to supplement RI subsurface soil data. Samples were collected near boring locations 38S13 and 38S14 (see Figure 1-5 in the main document) and analyzed for chromium using the Synthetic Precipitation Leaching Procedure (SPLP). The samples were collected using standard hand auger techniques, and were composited from that horizon immediately below the concrete cover to the depth of the water table (approximately 3 feet). Table G-1 below presents the both the bulk and the SPLP results summary for these samples. The laboratory results are provided in the following Attachment.

Table G-1
SPLP Sampling Results

Sample Location	Chromium Soil (mg/kg)	Chromium Leachate (µg/L)
38S013A	40.1	ND
38S013B	383	0.16
38S014A	0.99	ND

SPLP is typically used to define the leachability of soil constituents to a groundwater receptor. It has been recommended for this purpose by the USEPA (1994) as an element in soil-screening. The method consists of collecting split-sample volumes; one volume is subjected to a leaching agent of neutral pH (DI water) and the resulting leachate analyzed for parameters of concern, and the second volume is bulk-analyzed for the same parameters. The method results provide the ratio of leachate concentration over soil concentration. The SPLP method is particularly suited for inorganic constituents, in that the empirical results obtained are an inherent consequence of all of the factors influencing leachability in that particular sample.

Of the three samples, only one had detectable concentrations in the SPLP derived leachate. For this sample — 38S013B — the bulk (soil) analysis measured the chromium fraction at 383 mg/kg, and the associated leachate fraction was measured at 0.16 mg/l, which yields a consequent partitioning ratio of 4.17 E-4. Simplistically assuming this ratio remains linear through a range of concentrations, the maximum chromium fraction that could remain in soil

and still be protective of groundwater would be approximately 239 mg/kg (this assumption is simplistic in that not only does it assume the relationship to be linear, but it does not account for temporal variability in influencing factors, nor does it account for spatial heterogeneities in the soil matrix). Most importantly, this assumption places the soil matrix in uncontrolled direct contact with a leaching agent (precipitation); the fact remains that Site 38 conditions are the opposite by virtue of the concrete cover.

In summary, the SPLP sampling results indicate that a relatively high fraction of chromium would have to be present to pose a threat to groundwater. Site-specific conditions are such that the soil matrix is not directly exposed to a leaching agent. Also, the new samples are indicative of subsurface heterogeneity in that the concentrations were different from those in the RI suggesting there is not a source area with a lot of residual mass. Subsurface soil will not be addressed for protection of groundwater under current and future use scenarios as long as some type of cap or building foundation is maintained.

Attachment
Analytical Results for Leaching Evaluation

DATALCP2
08/25/97

PENSACOLA, SITE 38
Chromium Sampling - Building 71

Page: 1
Time: 08:28

PEN10 CR	SAMPLE ID ----->	038-S-013A-02	038-S-013B-02	038-S-014A-02	BLK-0-EN10-01		
	ORIGINAL ID ----->	038S013A02	038S013B02	038S014A02	MBLANK1		
	LAB SAMPLE ID ---->	S773416*1	S773416*2	S773416*3	S773416*4		
	SAMPLE DATE ----->	06/16/97	06/16/97	06/16/97			
	DATE EXTRACTED -->	06/17/97	06/17/97	06/17/97	06/17/97		
	DATE ANALYZED -->	06/18/97	06/18/97	06/18/97	06/18/97		
	MATRIX ----->	Soil	Soil	Soil	Soil		
	UNITS ----->	MG/KG A	MG/KG A	MG/KG A	MG/KG D		
CAS #	Parameter						
7440-47-3	Chromium (Cr)	40.1 J	383. J	0.99 J	0.25 J		

DATALCP2
08/25/97

PENSACOLA, SITE 38
Chromium Sampling - Building 71

Page: 2
Time: 08:28

PEN10 SPLP CR	SAMPLE ID ----->	038-S-013A-02	038-S-013B-02	038-S-014A-02	BLK-0-EN10-01		
	ORIGINAL ID ----->	038S013A02	038S013B02	038S014A02	MBLANK1		
	LAB SAMPLE ID ---->	S773416*1	S773416*2	S773416*3	S773416*4		
	SAMPLE DATE ----->	06/16/97	06/16/97	06/16/97	06/16/97		
	DATE EXTRACTED -->	06/18/97	06/18/97	06/18/97	06/18/97		
	DATE ANALYZED ---->	06/18/97	06/18/97	06/18/97	06/18/97		
	MATRIX ----->	Soil	Soil	Soil	Soil		
	UNITS ----->	MG/L A	MG/L A	MG/L A	MG/L D		
CAS #	Parameter						
7440-47-3	Chromium (Cr)	0.05 U	0.161	0.05 U	0.05 U		